



Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
BSc. Hons. (Eng.) in Electronic and Telecommunication Engineering
Semester 4 First Sit - Final Examination 2026

Batch : 07

Module Code: EE2324	Module Title: Communication I
Date: 08 June 2026	Duration: 03 Hours
Examiner	Dushani Munasinghe

Instructions to Candidates: (This is only a sample ,instructions may change)

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of four (04) questions and 07 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
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- Q1** i) A digital wireless communication system is used to transmit sensor data from an industrial monitoring station to a central control unit. During transmission, the received signal is corrupted by additive noise and interference from other wireless devices.

The received signal can be represented as,

$$r(t) = s(t) + n(t)$$

where $s(t)$ is the transmitted signal and $n(t)$ is a random noise process.

- a) Explain why the noise signal $n(t)$ is modeled as a random process rather than a deterministic signal. Discuss at least three physical sources of randomness encountered in practical communication systems. [05]
- b) In communication receiver design, engineers often assume that the noise process is: [03]
- Zero-mean
 - Wide-Sense Stationary (WSS)
 - Ergodic

Explain the significance of each assumption and how it simplifies communication system analysis.

- c) Explain the concept of autocorrelation and describe what information it provides about a random signal. [04]
- ii) A single-stage amplifier has a bandwidth of 100 kHz and operates at a temperature of 27°C. The amplifier has a power gain of 20 dB and a noise figure of 3 dB. A 50 kΩ resistor is connected to the amplifier input as the noise source. The amplifier output is connected to a 100 Ω load resistor.

Assuming the resistor generates only thermal noise, calculate:

- a) The RMS thermal noise voltage at the amplifier input. [03]
- b) The RMS noise voltage at the amplifier output due to the amplified input noise. [03]
- c) The output noise voltage considering the amplifier noise figure. [03]
- d) Briefly explain the significance of the noise figure in communication receiver design. [04]

Total [25]

- Q2. i)** A carrier signal of frequency 1.2 MHz and peak voltage 20 V is amplitude modulated by a sinusoidal message signal of frequency 8 kHz. The modulation index is 0.75. The load resistance is 50Ω .
- a) Write the mathematical expression for the AM wave. [01]
 - b) Determine the frequencies of the carrier, upper sideband, and lower sideband. [03]
 - c) Calculate the carrier power, power in each sideband, total sideband power, and total transmitted power. [04]
 - d) Determine the bandwidth required for transmission. [02]
 - e) Sketch the frequency spectrum showing the carrier and sideband components with relative power levels. [02]
 - f) Different AM transmission systems are used depending on bandwidth efficiency, power efficiency, and receiver complexity. [03]

Compare the following AM systems:

- DSB-FC
- DSB-SC
- SSB-FC

- ii)** An FM transmitter has a carrier frequency of 100 MHz and is modulated by an audio signal with a maximum frequency of 15 kHz. The maximum frequency deviation is 45 kHz.
- a) Calculate the modulation index of the FM signal. [02]
 - b) Using Carson's Rule, determine the transmission bandwidth required. [02]
 - c) Determine the frequencies of the first three upper and lower sideband pairs. [02]
 - d) Sketch the frequency spectrum of the FM signal showing the carrier and sidebands with normalized amplitudes represented as J_0 , J_1 , J_2 , and J_3 . [04]

Total [25]

- Q3. i)**
- a) Signals transmitted through optical fiber links experience attenuation. A laser source launches an optical power of 10 mW into a 50 km fiber link. The fiber attenuation is 0.3 dB/km and an optical amplifier with a gain of 12 dB is installed 30 km from the transmitter. Determine the optical power available at the receiver end. [04]
 - b) A transmitter delivers 20 W to an antenna having a gain of 5 dBi. The receiving antenna has a gain of 3 dBi. The carrier frequency is 2.4 GHz. Calculate the received power (in dBm) at 500 m. Assume free-space propagation. [04]
 - c) A communication cable exhibits a loss of 1.8 dB/km. A signal with an input power of 5 W is transmitted through a 60 km cable. A repeater with a gain of 50 dB is placed 20 km from the transmitter. Determine the signal power at the cable output. [04]
- ii) A Geostationary Earth Orbit (GEO) satellite is located 35,786 km from its earth station. The following information is given for the satellite uplink shown in Table 3.1.

Uplink frequency	12 GHz
Transmitter antenna gain	58 dBi
Atmospheric losses	35 dB
Received SNR	8 dB
Received noise power	20 pW
Receiver antenna gain	52 dBi
Receiver sensitivity	-105 dBW

Table 3.1

- a) Calculate the power transmitted from the earth station (in dBW). [03]
- b) Construct the complete uplink link budget and present it in a clear graphical/block-diagram format, showing all gains and losses. [06]
- c) Determine the fade margin of the communication link and comment on the reliability of the satellite uplink based on the value obtained. [04]

Total [25]

- Q4. i)** The process of converting an analog signal into a digital signal involves sampling and quantization.
- b) Define the sampling theorem and explain the consequence of violating the theorem. [02]
- b) Determine the minimum sampling frequency required for the signal [03]
- $$x(t) = 4 \cos(4000\pi t) + 2 \sin(12000\pi t) + 5 \cos(16000\pi t)$$

- ii)** Pulse modulation techniques are commonly used in communication systems. [06]

Compare the following three pulse modulation techniques:

- Pulse Amplitude Modulation (PAM)
- Pulse Width Modulation (PWM)
- Pulse Position Modulation (PPM)

Your answer should include:

- Principle of operation
- Sketches of the waveforms
- One advantage and one disadvantage of each technique

- iii)** A data acquisition system uses a 10-bit ADC with an input voltage range from 0 V to 8 V. Determine the following:
- a) The number of quantization levels. [02]
- b) The voltage resolution (quantization step size). [03]
- c) The maximum quantization error. [03]
- d) An engineer upgrades the ADC to a 14-bit converter while maintaining the same input range. Discuss the effect on: [06]
- Resolution
 - Quantization error
 - Signal representation accuracy

End of the Question Paper

Total [25]

Formula Sheet

Important constants

Boltzmann constant = $k = 1.38 \times 10^{-23} \text{ J/K}$

Noise

RMS noise voltage = $\sqrt{4kTBR}$

Noise factor (F) of a cascaded system = $F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \dots$

Noise figure (NF) = $10 \log (F)$

Modulation

Total transmitted power = $P_C + \frac{m^2 P_C}{4} + \frac{m^2 P_C}{4}$ (in AM)

Modulation index, $m_f = \frac{\delta}{f_i}$ (in FM)

Free space propagation

Friis equation, $P_R = \frac{P_T G_T G_R \lambda^2}{(4\pi R)^2}$

Quantization

number of quantized levels (L) = 2^n

Step size (Δ) = $\frac{x_{\max} - x_{\min}}{L}$

Appendix

FM side frequencies from the solutions of Bessel functions of the first kind (rotated Table 1)

Modulation Index (m_f)	n or Order of Sidebands																
	Carrier Frequency																
	J_0	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}	J_{11}	J_{12}	J_{13}	J_{14}	J_{15}	J_{16}
0.00	1.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.25	0.98	0.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.5	0.94	0.24	0.03	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1.0	0.77	0.44	0.11	0.02	—	—	—	—	—	—	—	—	—	—	—	—	—
1.5	0.51	0.56	0.23	0.06	0.01	—	—	—	—	—	—	—	—	—	—	—	—
2.0	0.22	0.58	0.35	0.13	0.03	—	—	—	—	—	—	—	—	—	—	—	—
2.5	-0.05	0.50	0.45	0.22	0.07	0.02	—	—	—	—	—	—	—	—	—	—	—
3.0	-0.26	0.34	0.49	0.31	0.13	0.04	0.01	—	—	—	—	—	—	—	—	—	—
4.0	-0.40	-0.07	0.36	0.43	0.28	0.13	0.05	0.02	—	—	—	—	—	—	—	—	—
5.0	-0.18	-0.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02	—	—	—	—	—	—	—	—
6.0	0.15	-0.28	-0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02	—	—	—	—	—	—	—
7.0	0.30	0.00	-0.30	-0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02	—	—	—	—	—	—
8.0	0.17	0.23	-0.11	-0.29	-0.10	0.19	0.34	0.32	0.22	0.13	0.06	0.03	—	—	—	—	—
9.0	-0.09	0.24	0.14	-0.18	-0.27	-0.06	0.20	0.33	0.30	0.21	0.12	0.06	0.03	0.01	—	—	—
10.0	-0.25	0.04	0.25	0.06	-0.22	-0.23	-0.01	0.22	0.31	0.29	0.20	0.12	0.06	0.03	0.01	—	—
12.0	0.05	-0.22	-0.08	0.20	0.18	-0.07	-0.24	-0.17	0.05	0.23	0.30	0.27	0.20	0.12	0.07	0.03	0.01
15.0	-0.01	0.21	0.04	-0.19	-0.12	0.13	0.21	0.03	-0.17	-0.22	-0.09	0.10	0.24	0.28	0.25	0.18	0.12



Faculty of Engineering
Department of Electrical & Electronics Engineering
BSc. Hons. (Eng.) in Mechatronics Engineering
Semester 04
First Sit - Final Examination 2026
Batch: 07

Module Code	EE2329	Module Title	Electrical Machines & Actuators
Date	06/06/2026	Duration	03 Hours
Examiner	MGJP Fernando		

Instructions to Candidates

- This is a closed book examination. No reference materials are allowed.
- This paper consists of **FIVE** Questions in **06** pages. Answer **ALL** questions.
- Marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.
- Use only the provided answer booklet and additional sheets. Write your student number on all sheets.
- Write clearly and legibly. Use a blue or black pen only.
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- If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator, or make reasonable assumptions. Clearly state such assumptions in your answer script.
- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.
- Considering permeability of free space as $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$

Materials Required

- CINEC answering Booklet & Extra answering paper

Q1

Redraw the diagram shown in **Figure 1.1** and complete it using your knowledge about types of electrical motors.

(i)

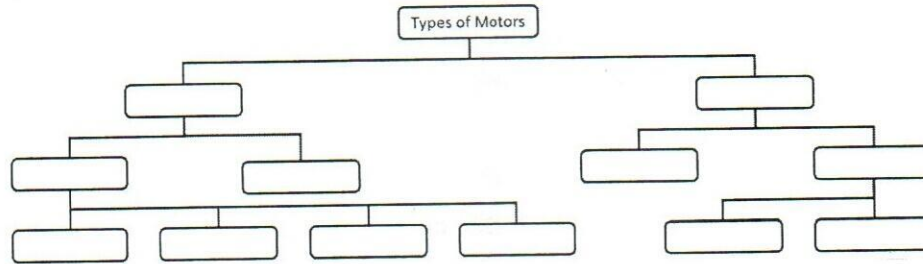


Figure 1.1

[3]

(ii)

Describe the difference between a Synchronous motor and an Induction motor.

[2]

(iii)

Discuss the advantages offered by Electric motors & actuators, over pneumatic systems.

[4]

(iv)

The linear dc machine shown in **Figure 1.2 (a)** has a DC supply voltage of 150 V, an internal resistance of 0.2Ω , and a magnetic flux density of 0.5 T directed into the page.

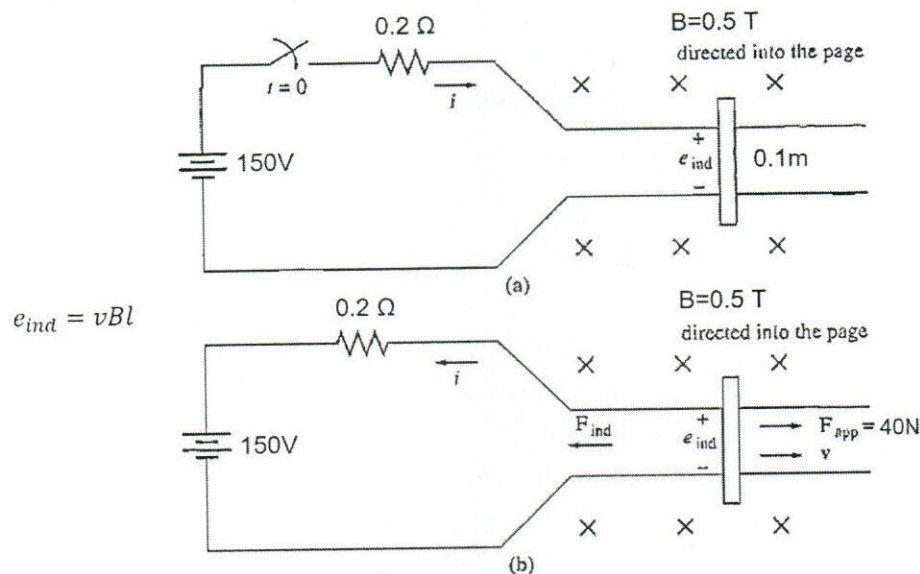


Figure 1.2

[a] What is this machine's maximum starting current?

[2]

[b] What is its steady-state velocity at no load?

[2]

[c] If a 40 N force pointing to the right was applied to the bar as shown in **Figure 1.2 (b)**, what would the steady-state speed be?

[4]

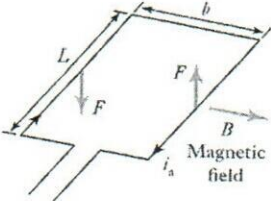
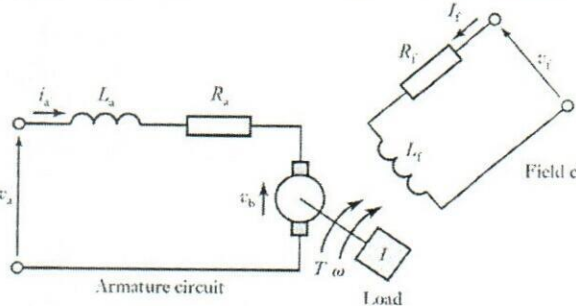
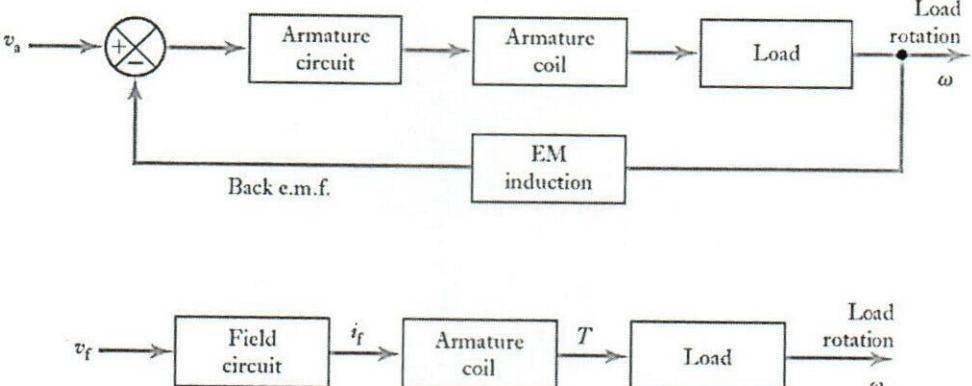
[d] Under the same force, how much power would the bar be producing or consuming and how much power would the supply be producing or consuming?

[2]

[e] Is this machine acting as a motor or as a generator?

[1]

[Q1 Total - 20 Marks]

Q2	(i) Describe how Series, Shunt, Sep-ex, and Compound DC motors differ from each other using their equivalent representations. [8]
(ii)	By referring the Figure 2.1, derive the equations which describes the torque-speed (T-ω) characteristics of armature-control and field control methodologies for a DC motor.   Figure 2.1
(iii)	Redraw the block diagrams in Figure 2.2 in your answer script and complete them using the relevant derived terms from part (ii).  Figure 2.2

[Q2 Total - 20 Marks]

Q3	(i) A 0.4A current goes through a coil with 500 turns. If the flux produced is 300 μ Wb, find, [a] The produced magnetomotive force (mmf) [b] The reluctance of the coil [2]
	(ii) What is the 'fringing effect' in a magnetic circuit, if there are air gaps in the flux path in a core? [4]

(iii)

A simplified rotor and stator for a DC motor is shown in **Figure 3.1**.

- The mean path length of the stator is **50 cm**, and its cross-sectional area is **12 cm²**.
- The mean path length of the rotor is **5 cm**, and its cross-sectional area also may be assumed as **12 cm²**.
- Each air gap between the rotor and the stator is **0.05 cm** wide, and the cross-sectional area of each air gap (including fringing) is **14 cm²**.
- The iron of the core has a relative permeability of **2000**, and there are **200** turns of wire on the core.
- If the current in the wire is adjusted to be **1 A**, what will be the resulting flux density in the air gaps?

[8]

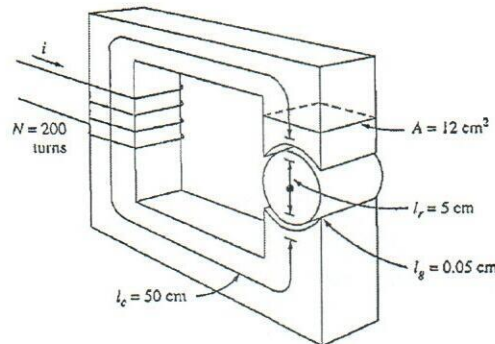


Figure 3.1

(iv)

The two-legged core shown in **Figure 3.2** has two windings, and the winding on the left leg of the core (N_1) has 400 turns, and the winding on the right (N_2) has 300 turns. The coils are wound in the directions shown in the figure. If the dimensions are as shown, what would be the total flux produced in the core if the applied currents are $i_1 = 0.5$ A and $i_2 = 0.75$ A? Assume $\mu_r = 1000$ and constant.

[6]

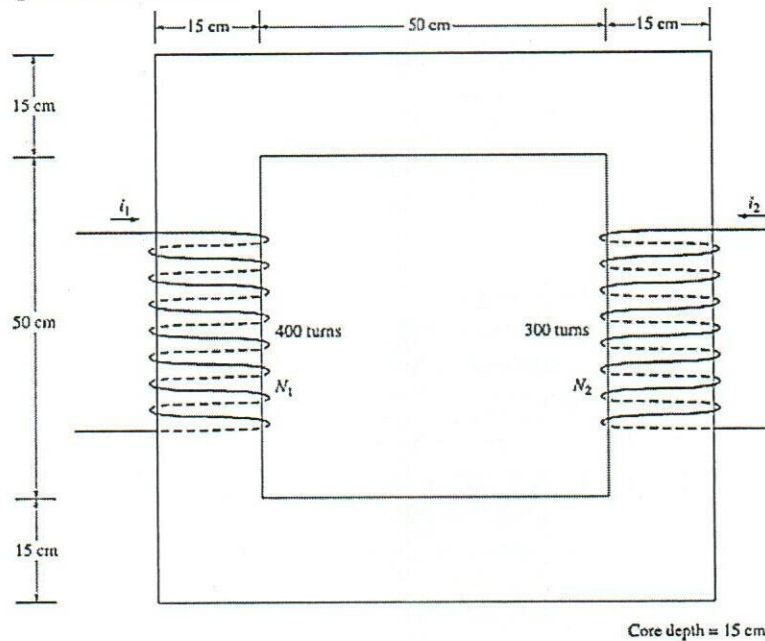
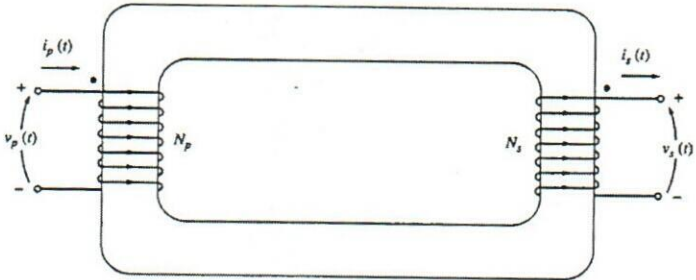
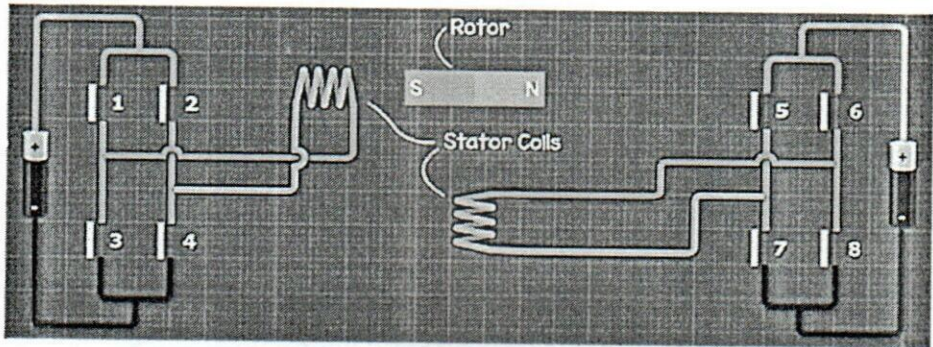


Figure 3.2

[Q3 Total - 20 Marks]

Q4	(i)	Illustrate the general schematic diagram of a 250V AC to 5V DC rectifier circuit (Stepping down, FWR, and Smoothing) along with the waveforms of each section of the circuit.	[6]
	(ii)	Explain the requirement of transformers in electrical power generation and distribution.	[2]
	(iii)	By referring the diagram in Figure 4.1 using general notations, state the equations which describes the relationship between voltage, current, and number of turns. 	[2]
	(iv)	A transformer has a primary current of 5 A and a primary voltage of 4,800 V. The secondary current is 90 A, and the secondary voltage is 240 V. Determine the efficiency of the transformer.	[3]
	(v)	Explain the main four losses in Real Transformers.	[4]
	(vi)	A transformer rating is provided as 2kVA, 500/50, 60 Hz. [a] What is the apparent power of the transformer? [b] What is the turns ration of the transformer? [c] What are the rated primary and secondary currents of the transformer?	[3]

[Q4 Total - 20 Marks]

Q5	(i)	Explain the principle of Mutual Inductance.	[2]
	(ii)	What are the 3 primary types of electrical braking?	[3]
	(iii)	By referring the diagram in Figure 5.1 , explain how a H-Bridge is used to control the direction and the speed of a Stepper motor. 	[3]

(iv) Compare the advantages and disadvantages of brushless DC motors (BLDC). [2]

Figure 5.2 shows a 3-Point starter used for a DC motor.

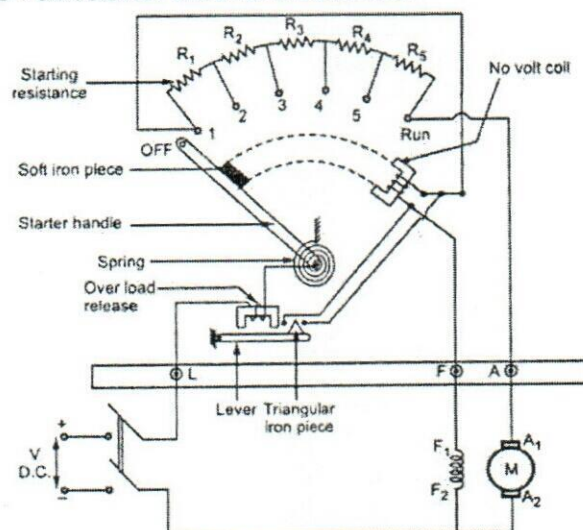


Figure 5.2

[a] Explain the necessity of a DC motor starter for a practical DC motor. [3]

[b] What are the international standards which must be considered when selecting a motor starter for an application? [2]

[c] Describe the operation of the 3-point starter shown in the above figure. [3]

(vi) Illustrate and describe the operation of a plunger type solenoid. [2]

[Q5 Total - 20 Marks]

*** End of the Question Paper ***



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc. Hons. (Eng.) in Electronic & Telecommunication Engineering
Semester 4 First Sit - Final Examination 2026
Batch : 07

Module Code: EE2322	Module Title: Communication Systems
Date: 06 th June 2026	Duration: 3 hrs
Examiners :	Ms.Bashini Premathilake Mr.Wipula Wimalshanthi

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed unless specified.
- This paper consists of Five (5) questions and 8 pages. Answer all questions.
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Q1

- i) Define a communication system and explain the functions of any two components of a communication system. [03]
- ii) Explain the fundamental wave propagation phenomena of reflection, refraction, diffraction and absorption. [04]
- iii) A parallel two-wire transmission line consists of copper conductors of radius 0.8 mm separated by a distance of 1.8 cm. The line is embedded in a dielectric medium with relative permittivity (ϵ_r) = 3.2 and conductivity (σ) = 5×10^{-14} S/m. Determine the line parameters R' , L' , G' , and C' at an operating frequency of 1.5 GHz.
- Conductivity of copper (σ_c) = 5.8×10^7 S/m (copper)
- Permeability of air (μ_0) = $4\pi \times 10^{-7}$ H/m
- Permittivity of air (ϵ_0) = 8.85×10^{-12} F/m
- Use the relevant equations provided in the formula sheet at the end of the question paper. [08]
- iv) A coaxial transmission line has an effective series inductance per unit length of $0.35 \mu\text{H}/\text{m}$ and an effective shunt capacitance per unit length of $65 \text{ pF}/\text{m}$.
- a) Determine the characteristic impedance (Z_0) of the line. [02]
- b) If the outer conductor diameter of the cable is 9 mm and the dielectric material has a relative permittivity of $\epsilon_r = 2.6$, calculate the diameter of the inner conductor. [03]

Total [20]

Q2.

- i) Answer the following questions on satellite communication systems.
- a) Explain the *Angle of Inclination* and *Angle of Elevation* of satellites using suitable diagrams. [04]
- b) State the approximate frequency spectrum allocations used for uplink and downlink communication in the C band, Ku band, and Ka band. [03]

- c) A satellite is located 420,000 km from the Earth. Calculate the time taken for a radio signal to travel from the satellite to the Earth. Assume the velocity of electromagnetic waves is 3×10^8 m/s. [01]
- d) A satellite communication system transmits a downlink signal with an output power of 12 W. The transmitting antenna has a gain of 42 dB. The feeder loss and antenna pointing loss are 1.2 dB and 0.5 dB respectively. Calculate the Effective Isotropic Radiated Power (EIRP) in dBW. [02]
- ii) Answer the following questions on terrestrial communication systems.
- a) State the minimum clearance requirement of obstacles within the first Fresnel zone to minimize signal fading. Explain with the aid of a diagram. [03]
- b) The radius of the first Fresnel zone at a particular point in a wireless communication link is 12 m. An obstacle provides a clearance of 8 m from the line-of-sight path. Determine whether the clearance is sufficient to minimize signal fading. Justify your answer. [02]
- c) A microwave communication link operates at a carrier frequency of 4.5 GHz and the distance between the transmitter and receiver is 18 km.
- (i). Calculate the radius of the first Fresnel zone at a point 7 km from the transmitter. [03]
- (ii). If an obstacle penetrates the first Fresnel zone at this location, determine the maximum allowable obstacle penetration to maintain reliable communication. [02]
- Total [20]**

Q3.

- i) Define a Wireless Local Area Network (WLAN). State two advantages and two limitations of WLANs. [03]
- ii) Explain three important roles of antenna gain in wireless communication systems. [03]

- iii) Define receiver sensitivity and explain its importance in two aspects of link budget calculations. [03]
- iv) What is meant by link margin? Explain why a positive link margin is desirable. [03]
- v) You are required to evaluate the feasibility of a proposed point-to-point wireless communication link with the following specifications. Use the relevant equation provided in the formula sheet at the end of the question paper to calculate the Free Space Path Loss (FSPL).
- Distance between the access point and client device: 6 km
 - Frequency of operation: 5.8 GHz
 - Access point specifications:
 - Antenna gain: 14 dBi
 - Transmit power: 22 dBm
 - Receiver sensitivity: - 82 dBm
 - Cable loss at access point: 1.5 dB
 - Client device:
 - Antenna gain: 18 dBi
 - Transmit power: 20 dBm
 - Receiver sensitivity: - 76 dBm
 - Cable loss at the device: 1 dB
- a) Determine the link margin for the *access point-to-client* link. Hence, comment on the feasibility of the communication link with suitable justification. [04]
- b) Determine the link margin for the *client-to-access point* link. Hence, comment on the feasibility of the communication link with suitable justification. [04]

Total [20]

Q4. For parts (v) and (vi), use the relevant equations provided in the formula sheet at the end of the question paper.

- i) Explain three advantages of optical fibre communication systems compared with conventional electrical communication systems. [03]
- ii) Compare single-mode and multimode optical fibres with respect to three characteristics. [03]
- iii) Explain the concept of dispersion and state two effects of dispersion in optical fibre communication systems. [03]
- iv) State the three commonly used operating wavelengths in optical fibre communication systems. [03]
- v) An optical fibre has a core refractive index of 1.48 and a cladding refractive index of 1.45. Calculate the following parameters of the fibre.
 - a) Critical angle at the core–cladding interface
 - b) Numerical aperture (NA)
 - c) Acceptance angle in air [04]
- vi) A step-index optical fibre has a core diameter of $62.5\text{ }\mu\text{m}$ and a relative refractive index difference of 1.8%. The refractive index of the core is 1.52. Calculate the following parameters.
 - a) Numerical aperture of the fibre
 - b) Normalized frequency (V number) at a wavelength of 850 nm
 - c) Approximate number of guided modes supported by the fibre [04]

Total [20]

Q5.

- i) Name 03 types of Primary Radar systems currently in use and indicate at least 01 application of each system. [03]

- ii) In a pulsed Radar system, Radar receiver is designed to receive a minimum power level of 0.1 pW, calculate the maximum achievable range of the Primary Radar system for an aircraft with Radar cross section of 2m^2 .

You may use relevant equations provided in the formula sheet at the end of the question paper.

The Radar system operates in following configuration;
 $P_t = 2.5\text{ MW}$, $G = 36\text{ dB}$, Transmit frequency = $1,340\text{ MHz}$
 (Speed of light = $3 \times 10^8\text{ m/s}$)

[07]

- iii) Explain the Receiver Side Lobe Suppression (RSLs) function of a Secondary Surveillance Radar (SSR) system if the aircraft being detected does not possess Interrogator Side Lobe Suppression (ISLS) function. Explanation shall consist of sketches of relevant SSR antenna radiation patterns and Interrogation pulses of P_1 , P_3 and P_2 .

[04]

- iv) Explain the basic operation of a Multilateration (MLAT) system in a 2-dimensional space using appropriate sketches. [03]

Identify 04 benefits of MLAT technology. [03]

Total [20]

End of the Question Paper

Formula sheet

- Line parameter formulas :

The effective surface resistance of the line (R_s):

$$R_s = \sqrt{\frac{\pi f \mu_c}{\sigma_c}}$$

Effective Series Resistance (R')

$$R' = \frac{2R_s}{\pi d} \Omega/m$$

Effective Series Inductance

$$L' = \frac{\mu}{\pi} \ln \left[(D/d) + \sqrt{(D/d)^2 - 1} \right] H/m$$

Effective Shunt Conductance

$$G' = \frac{\pi \sigma}{\ln \left[(D/d) + \sqrt{(D/d)^2 - 1} \right]} S/m$$

Effective Shunt Capacitance

$$C' = \frac{\pi \epsilon}{\ln \left[(D/d) + \sqrt{(D/d)^2 - 1} \right]} F/m$$

- D – Separation between the two conductors
- d – Diameter of the conductor

- Free Space Path Loss :

$$FSPL = 92.44 + 20 \log(d) + 20 \log(f)$$

d = distance between transmitter and receiver in km

f = signal frequency in GHz

- Fiber Equations :

$$NA = n_1 \sin \theta_A = \sqrt{(n_1^2 - n_2^2)}$$

$$\theta_A = \sin^{-1} NA$$

$$NA = n_1 \sqrt{2\Delta}$$

$$V = \frac{2\pi a}{\lambda} NA$$

$$M = \frac{V^2}{2}$$

NA = Numerical Aperture

θ_A = Acceptance angle

n = refractive index of air

n_1 = refractive index of core

n_2 = refractive index of cladding

Δ = core-cladding index difference

V = normalized frequency of the fibre

a = core radius

λ = wavelength

M = total number of modes

- Radar Equations :

$$R_{max} = \sqrt[4]{\frac{P_t G \sigma A_r}{16\pi^2 P_{r(min)}}} \text{ meters}$$

Where;

$$A_r = G\lambda^2 / 4\pi$$

R_{max} – Maximum achievable range (m)

P_t – Transmitted Power (W)

G – Transmit / Receive Antenna Gain

σ – Radar Cross Section of Aircraft (m²)

A_r – Effective Antenna Aperture (m²)

λ - Wavelength of Transmit frequency (m)

$P_{r(min)}$ – Minimum receivable power of the Radar Receiver (W)



Faculty of Engineering & Technology
Department of Electrical & Electronics Engineering
BSc Hons (Eng) Mechatronics Engineering
Semester 4 First Sit - Final Examination 2026
Batch :7

Module Code: EE2328	Module Title: Microcontroller Engineering
Date: 04.06.2026	Duration: 3 Hrs
Examiner 1: Examiner 2:	Ms.Isuri Amanda Hennayaka

Instructions to Candidates:

- This is a **closed book examination**. No reference materials are allowed unless specified.
- This paper consists of **four questions**. **Answer all questions**.
- The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Write clearly and legibly. Use a blue or black pen only.
- Write your student number on all sheets.
- Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.

- Total [25]

-

2 of 5

- iii Design a "temperature alarm system" with 3 environmental sensors: a heat sensor (H), a humidity sensor (U), and a pressure sensor (P). [8]

The alarm output (A) activates only when at least 2 of the 3 sensors exceeds their threshold.

Assume logic 1 = threshold exceeded, logic 0 = normal.

- Set up the truth table for all input combinations
- Derive the Boolean equation using a Karnaugh map (K-map)
- Simplify the expression to Sum of Products (SOP) form
- Draw the logic diagram using basic gates (AND, OR, NOT)

- iv Describe a register and classify them by [3]

- How data enters/exits the register
- By input/output type
- By application

Total [25]

- Q3. i Analyze the structural and operational characteristics of SRAM, DRAM, Flash, and ROM, and compare their performance, volatility, and typical applications in embedded systems. [4]

- ii Describe the differences between ripple counter and synchronous counter. [1]

- iii Design a two-bit synchronous counter using J-K flip-flop. Include, [10]

- Excitation table of J-K flip-flop,
- State diagram
- Excitation table for the circuit
- K-Maps

- iv Design three-bit synchronous up counter using T flip-flop. Include, [10]

- Excitation table of T flip-flop,
- State diagram
- Excitation table for the circuit
- K-Maps

Total [25]

- Q4. i** Compare Mealy and Moore machines. In your answer, describe the structure of each, [5]
explain how their outputs are determined, and identify the key difference between them.
- ii** Draw the state transition table for the following state machine. [2]

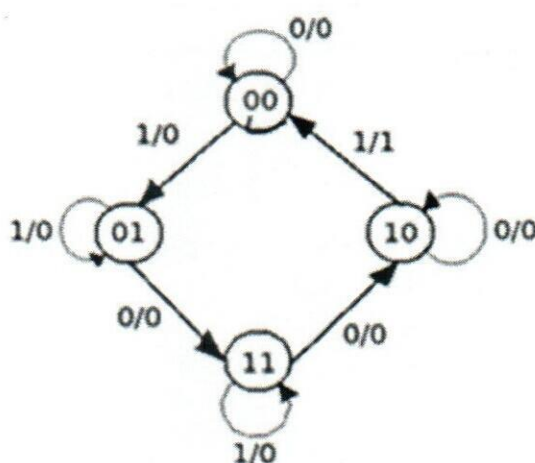


Figure 2

- iii** Draw the state table for the following state diagram using J-K flip-flop [5]

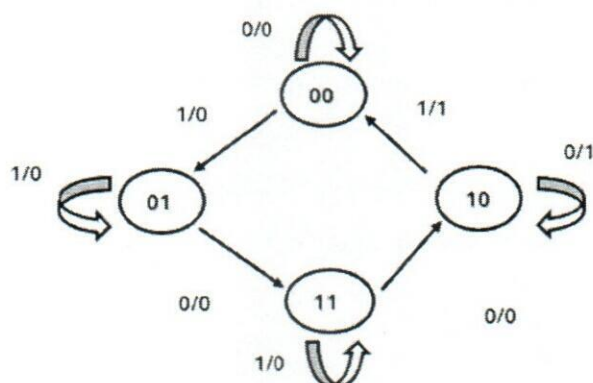


Figure 3

- | | | |
|--------------|--|-------------|
| iv | Define state assignment and justify its importance in the design of sequential logic circuits. | [2] |
| v | Categorize the three types of state assignment and elaborate on the distinguishing characteristics of each. | [3] |
| vi | Identify the three main methods of interfacing a device to a PC | [3] |
| vii | Analyze the mechanism of synchronous communication and explain how synchronization is achieved between transmitting and receiving devices. | [2] |
| viii | Classify the three types of serial communication based on timing considerations and distinguish between them using appropriate examples. | [3] |
| Total | | [25] |

End of the question paper



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc. Hons. (Eng.) in Electronic and Telecommunication Engineering
Semester 4 First Sit - Final Examination 2026
Batch : 7

Module Code: EE2325	Module Title: Computer Organization
Date: 04th June 2026	Duration: 03 hours (0900-1200)
Examiner 1:	Srimal Punchihewa
Examiner 2:	Dr. Keerthi Gunawickrama

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of seven (7) questions and 7 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*

Q1 i)

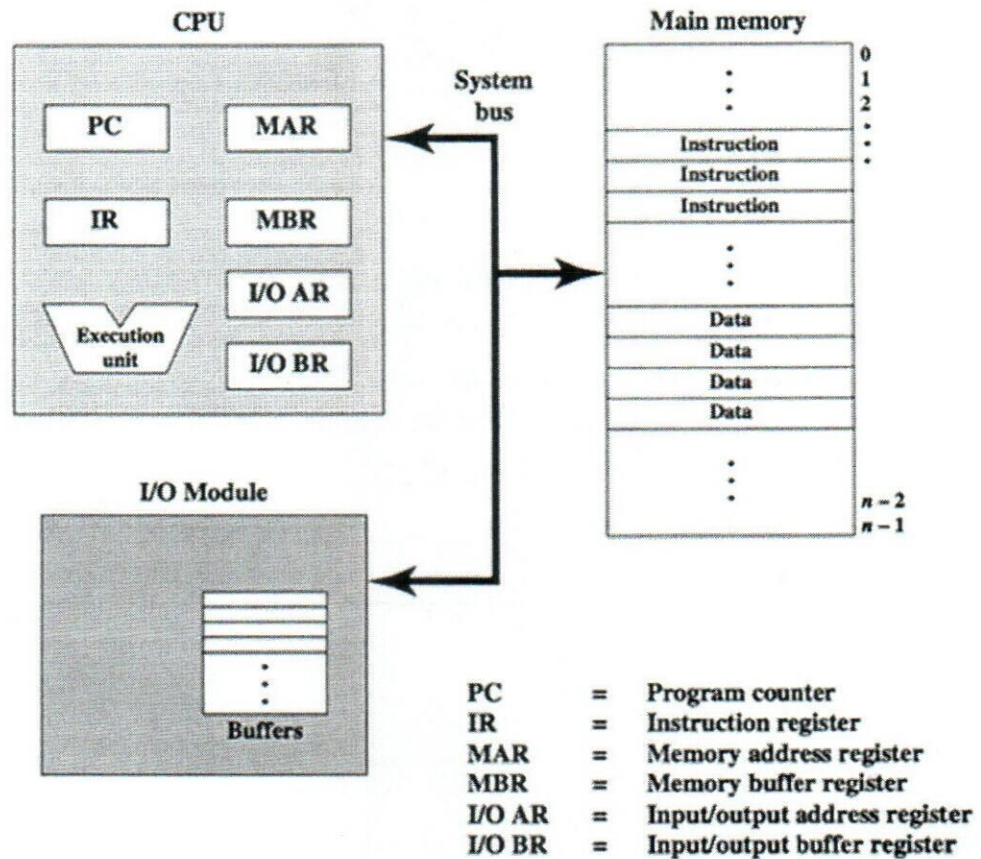


Figure 1

Figure 1 shows a top-level view of main computer components.

Briefly describe the function of each of the following items

- | | |
|----------------------------|-------|
| a) Program Counter | [02] |
| b) Instruction Register | [02] |
| c) Memory Address Register | [02] |
| d) I/O Address Register | [02] |
| e) I/O Module | [02] |

Total [10]

- Q2. i)** A CPU has a clock frequency of 50 MHz. [03]
- Memory access time is 65 ns.
- Memory write time is 75 ns.
- Calculate the number of clock pulses needed for read / write operations.
- ii)** Describe briefly the method adopted for erasure of:
- a) Read Only Memory (ROM) [01]
 - b) Programmable ROM (PROM) [01]
 - c) Flash Memory [01]
- iii)** Tabulate the advantages and disadvantages of DRAM and SRAM. [05]
- iv)**

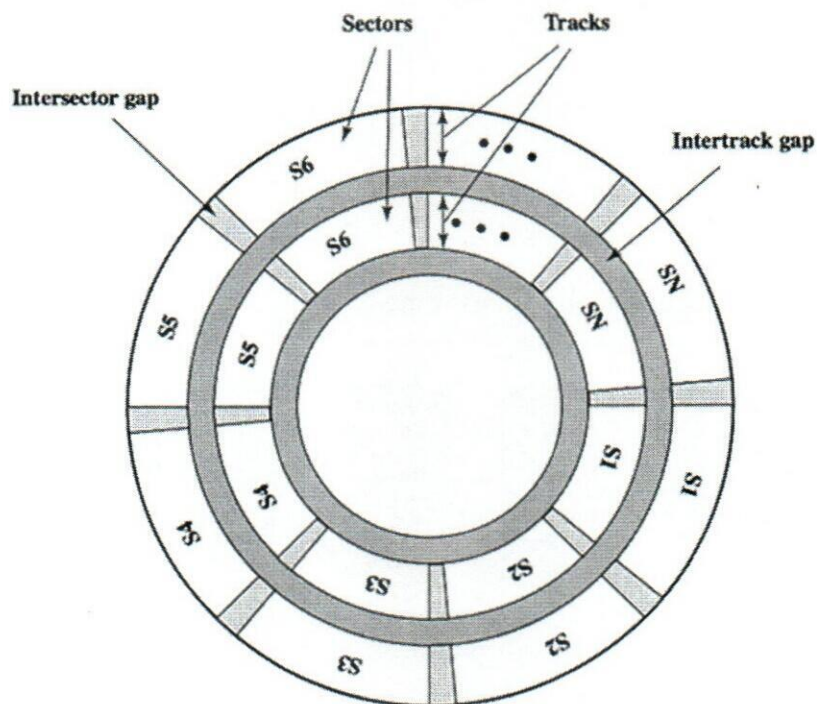


Figure 2

Figure 2 shows Disk Data Layout

- a) Discuss briefly the significance of inter track gaps. [02]

v)

Characteristics	Constellation ES.2	Seagate Barracuda XT	Cheetah NS	Momentum
Application	Enterprise	Desktop	Network attached storage, application servers	Laptop
Capacity	3 TB	3 TB	400 GB	640 GB
Average seek time	8.5 ms read 9.5 ms write	N/A	3.9 ms read 4.2 ms write	13 ms
Spindle speed	7200 rpm	7200 rpm	10,075 rpm	5400 rpm
Average latency	4.16 ms	4.16 ms	2.98	5.6 ms
Maximum sustained transfer rate	155 MB/s	149 MB/s	97 MB/s	300 MB/s
Bytes per sector	512	512	512	4096
Tracks per cylinder (number of platter surfaces)	8	10	8	4
Cache	64 MB	64 MB	16 MB	8 MB

Figure 3

Figure 3 shows typical hard disk driver parameters

- a) Discuss briefly the meaning of seek time. [02]
- b) If a hard disk is rotating at 20000 rpm, calculate the average rotational delay. [02]
- c) Discuss briefly the Access time. [02]

vi)

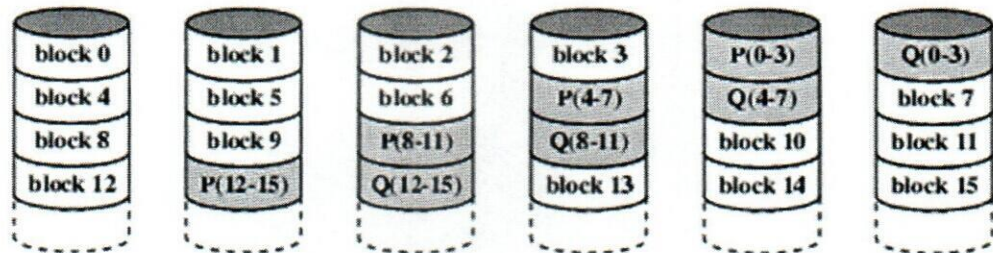


Figure 4

Figure 4 shows RAID 6 arrangement

- a) Discuss briefly how the parity information is stored. [02]
- b) Comment briefly on data availability of RAID 6 arrangement. [02]

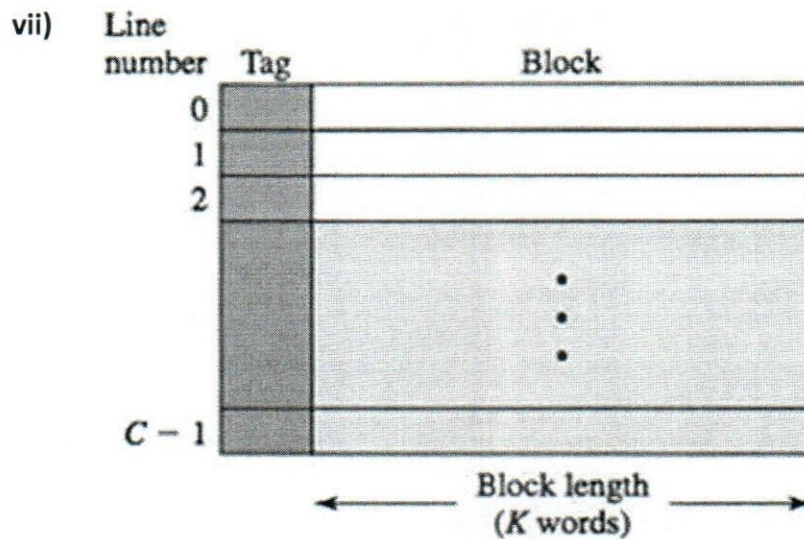


Figure 5

Figure 5 shows the structure of Cache Memory.

- a) Briefly discuss the significance of tag field. [02]

Total [25]

- Q3. i) Discuss briefly the meaning of Write Miss. [05]

- ii) If a Write Miss occurs in a local cache and no other cache has a modified copy of the requested line, discuss briefly the possible scenarios. [10]

Total [15]

- Q4. i) External or peripheral devices can be broadly classified into three categories

- a) Discuss briefly these categories citing suitable examples. [05]

- ii) Discuss briefly the three techniques that are possible for I/O operations. [02]

- iii) DMA mechanism can be configured in three ways.

- a) Name the three ways. [03]

- b) Briefly explain one of the above three ways using a suitable illustration. [05]

Total [15]

Q5. i) State the four parts of an Assembly Language instruction. [02]

ii)

```
mov  eax,10000h
add  eax,40000h
sub  eax,20000h
```

Figure 6

Figure 6 shows a portion of an Assembly language code

a) Discuss briefly the outcome of each instruction. [03]

iii) Discuss briefly the outcome of Assembly Language directive, [03]

Var1 BYTE 20 DUP(?)

iv) Discuss briefly how the data are stored in the memory using Little Endian Order as the outcome of the following Assembly Language directive. [03]

Val1 DWORD 12345678h

v)

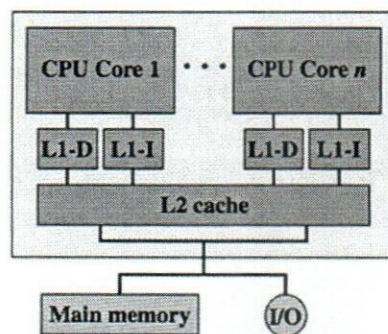


Figure 7

Figure 7 shows the Multi Core structure of Intel Core Duo.

a) Discuss briefly the above Multi Core structure. [05]

Total [15]

- Q6. i) Ultra DMA uses DDR and CRC. Discuss briefly each of the two terms DDR and CRC. [06]
- ii) Compare and Contrast First-party DMA and Third-party DMA. [04]

Total [10]

Q7. i)

Decode		Window	Execute			Write		Cycle
I1	I2							1
I3	I4	I1, I2	I1	I2				2
I5	I6	I3, I4	I1		I3	I2		3
		I4, I5, I6		I6	I4	I1	I3	4
		I5		I5		I4	I6	5
						I5		6

Figure 8

Figure 8 shows an example of out-of-order completion.

- a) Discuss briefly the out-of-order issue with the out-of-order completion shown in Figure 8. [05]
- ii) Compare and contrast superscalar and superpipelined implementations. [05]

Total [10]

End of the Question Paper



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc. Hons. (Eng.) in Automotive/ Mechanical Engineering
Semester 4 Final Examination 2026

Batch: 07

Module Code: EE2327	Module Title: Electrical Power and Machines
Date: 04th June 2026	Duration: 3 hrs
Examiner:	Eng (Ms) Shasiprabha Mihihansi

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed.*
- *This paper consists of five (05) questions and 5 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- ***Start each question on a new page** in the answer booklet, answer sheets. **Clearly indicate the question number at the top of the page.***
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*
- *Assume reasonable values for any data not given in or with the examination paper. Clearly state such assumptions made on the script.*
- *If you have any doubt as to the interpretation of the wording of a question, make your own decision, but clearly state it on the script.*

- Q1 i)** A magnetic core made of cast steel has a mean magnetic path length of 60 cm and a uniform cross-sectional area of 8 cm^2 . The core is wound with a coil of 500 turns carrying a current of 2 A. The relative permeability of the core material is 1200. The length of the air gap is 3 cm. ($\mu_0 = 4\pi \times 10^{-7}$)
- Calculate the reluctance of the iron core and the air gap [03]
 - Determine the total reluctance of the magnetic circuit. [02]
 - Calculate the magnetic flux produced in the core. [02]
 - Determine the flux density in the air gap. [02]
 - State three differences between electric circuits and magnetic circuits. [04]
- ii)** A transformer is a static electrical device that operates based on the principle of electromagnetic induction, transferring electrical energy from one circuit to another while changing the voltage or current level without changing the frequency.
- Define an ideal transformer and the characteristics of an ideal transformer. [03]
 - The total core loss of an iron steel is found to be 1500 W at 50 Hz. Keeping the flux density constant, the loss becomes 3000 W when the frequency is raised to 75 Hz. Calculate the hysteresis and eddy current loss at each of those frequencies. [04]

Total [20]

- Q2 i)** The single-line diagram of a three-phase system is shown in Figure 1. Using the common base $S = 50 \text{ MVA}$, draw the impedance diagram in per unit including the load impedance. The manufacturer's nominal ratings are given as follows:

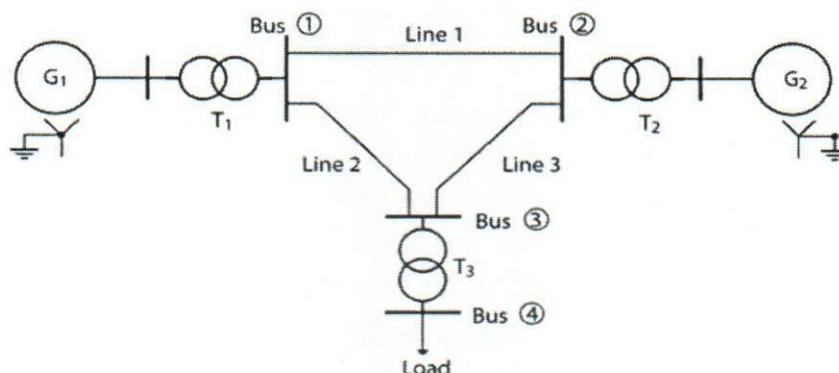


Figure 1

The three-phase load at bus 4 absorbs 60 MVA at 0.75 power factor (lagging), and lines 1, 2, and 3 have the reactance of 40Ω , 32Ω , and 30Ω , respectively.

Total [20]

- Q3. i)** An industrial plant is supplied from a 11 kV distribution feeder through a step-down transformer. The system includes protective devices such as circuit breakers, fuses, isolators, and load switches to ensure safe and reliable operation.
- Explain the typical structure of an industrial electrical distribution system from the utility supply point to the end loads. [03]
 - Differentiate between a fuse and a circuit breaker [03]

- ii) A utility company supplies electricity to a mixed consumer base including residential, commercial, and industrial customers. The system is supported by a combination of hydro and thermal power plants.

The following data is available for a 24-hour period:

- Maximum demand on the system: 120 MW
- Total energy generated per day: 2,400 MWh
- Number of consumers connected: 10,000
- Individual maximum demands (summation): 180 MW
- Average load factor of the system: unknown
- Fixed annual cost of the power system: Rs. 1.2 billion
- Annual running cost: Rs. 600 million

- a) State 2 renewable and 2 non-renewable energy generation methodologies in Sri Lanka. [01]
- b) State advantages and disadvantages of hydro and thermal power generation (2 for each). [04]
- c) Calculate The load factor and the diversity factor of the system [05]
- d) Calculate:
- Total annual cost of electricity supply
 - Cost per kWh of energy generated

Assume the plant operates throughout the year (365 days) [04]

Total [20]

- Q4. i) A utility company is integrating an Energy Storage System (ESS) into a 33 kV distribution network to improve grid stability and support renewable energy integration. The system uses a lithium-ion battery bank connected through a bidirectional converter.

- a) State 3 issues related to the traditional grid in Sri Lanka. [02]
Explain the importance of Energy Storage Systems (ESS) in power system operations, clearly describing how they help overcome the limitations and challenges associated with traditional power grids. [04]
- b) operations, clearly describing how they help overcome the limitations and challenges associated with traditional power grids. [04]
- c) State 2 advantages and 2 disadvantages of lithium-ion battery storage systems. [04]

- ii) Analyze your knowledge regarding Induction machines.

- a) A three phase, 12 pole, salient pole synchronous generator is connected to a diesel engine running at 500 rpm. It supplies an induction motor which has a full load speed of 1440 rpm. Taking the synchronous speed as 1500 rpm, find the percentage slip and number of poles of the induction motor. [04]
- b) The Figure 2 illustrates a motor starting method. Identify the method and analyze its operating principle. Also, specify an application where this starting method is commonly used. [06]

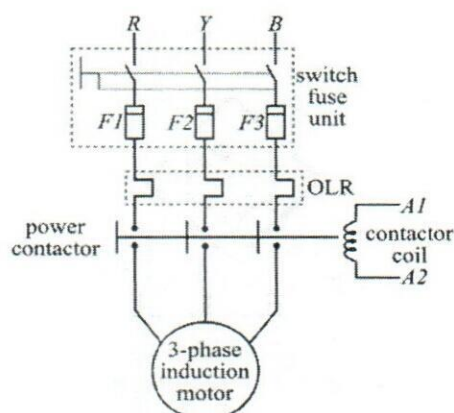


Figure 2

Total [20]

- Q5. i) A 75 kW, 3 Φ , Y-connected, 50Hz, 440V cylindrical rotor synchronous motor operates at rated condition with 0.8 p.f. leading. The motor efficiency excluding field and stator losses, is 95% and $X_s = 2.5 \Omega$.
- Calculate mechanical power developed [02]
 - armature current [04]
 - back e.m.f. [03]
 - power angle [01]
- ii) A series DC motor has a total armature and field resistance of 1.2Ω . When the motor is energized from a 48 V supply under starting (zero-speed) conditions, it produces a torque of 1500 Nm.
- Determine the starting armature current and evaluate the motor's combined torque constant k_c . [02]
 - Compute the developed torque when the motor is running at a speed of 500 rpm. [03]
 - Find the output power and efficiency at 500 rpm, assuming mechanical losses are negligible. [03]
 - Explain why DC machines are still used in some applications despite the widespread use of AC machines. [02]

Total [20]

Table 1 – [For Question 2]

Device	S_n	$U(L-L)_n$	X_n
Generator G1:	48 MVA	20 kV	20%
Generator G2:	25 MVA	13.8 kV	15%
Transformer T1:	50 MVA	20/110 kV	8%
Transformer T2:	30 MVA	13.8/110 kV	6%
Transformer T3:	50 MVA	11/110 kV	10%

List of Equations

$$P_e = k_e f^2$$

$$P_h = k_h f$$

$$E_A = k_c I_A \omega$$

$$\eta = \frac{E_A}{V_T}$$

$$V_T = I_A (k_c \omega + R_A + R_s)$$

$$P_{in} = \sqrt{3} V_a I_a \cos \vartheta$$

$$V = E_b + j I X_s$$

$$\mathcal{R} = \frac{l}{\mu A}$$

$$B = \frac{\Phi}{A}$$

$$\text{Load Factor} = \frac{\text{Average Load}}{\text{Maximum Demand}}$$

$$\text{Diversity Factor} = \frac{\text{Sum of Individual Max Demands}}{\text{Maximum System Demand}}$$

$$\Phi = \frac{NI}{\mathcal{R}_{total}}$$

$$Z_{load} = \frac{V^2}{S_L^*}$$

$$Z_{base} = \frac{V_{base}^2}{S_{base}}$$

$$\sin \delta = I X_s \cos \phi / E$$

$$Z_{pu}^{new} = Z_{pu}^{old} \times \left(\frac{V_B^{old}}{V_B^{new}} \right)^2 \times \left(\frac{S_B^{new}}{S_B^{old}} \right)$$

$$T = k_c I_a^2$$

End of the Question Paper



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
BSc Hons (Eng) Mechatronics Engineering
Semester 4 First Sit - Final Examination 2026

Batch: 07

Module Code: EE2323	Module Title: Electronic Design and Realization
Date: 02/06/2026	Duration: 03 hours
Examiner	Ms. Gayani Jayangi

Instructions to Candidates

- This is a closed book examination. No reference materials are allowed unless specified.
- This paper consists of 2 Parts. **Part A** contains 15 MCQ questions and **Part B** contains 4 essay type questions. **You should answer all questions.**
- In **Part A**, you must indicate the correct answer on the MCQ answer sheet given in Annex I and attach to your answer script. Each question carries 2 marks.
- In **Part B**, the marks allocated to each question are listed in the column on the far right. The final mark of the question paper will be calculated out of 100.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Write clearly and legibly. Use a blue or black pen only.
- Write your student number on all sheets.
- Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.

Part A - MCQ

- 1 A student is designing a **smart traffic light control system** for a busy city junction. The system uses sensors to detect vehicle density and automatically adjusts the signal timing to reduce traffic congestion. The design includes a microcontroller, sensors, communication modules, and real-time decision-making functions.

Which of the following best explains the importance of embedded systems in this application?

- A Embedded systems are mainly used to increase the physical size of electronic devices.
 - B Embedded systems provide dedicated real-time control and efficient processing for specific engineering applications.
 - C Embedded systems are only useful for storing large amounts of multimedia data.
 - D Embedded systems eliminate the need for sensors and communication networks.
- 2 A group of Engineers developed a **smart home security system** using embedded controllers and wireless communication modules. Before releasing the product to customers, the development team tested the system internally in a controlled laboratory environment to identify software bugs, hardware integration issues, and communication failures. Which type of testing is mainly described in this situation?
- A Beta Testing
 - B Unit Testing
 - C Alpha Testing
 - D Acceptance Testing
- 3 What is the primary advantage of using EDA software in schematic design?
- A It enables automatic fabrication of the complete electronic product without further design verification.
 - B It assists in circuit representation, component connectivity verification, and error detection prior to hardware implementation.
 - C It eliminates the requirement for circuit simulation and testing procedures.
 - D It directly improves the electrical power efficiency of the designed circuit.

- 4 During the PCB design process, a Design Rule Check (DRC) is performed. Which of the following issues is the DRC LEAST likely to detect?
- A Insufficient clearance between traces.
 - B Incorrect component footprints.
 - C Minimum trace width violations.
 - D Inadequate power supply decoupling.
- 5 An IoT-based industrial monitoring system transmits sensor data to a cloud server through the internet. During evaluation, engineers identified a vulnerability that could allow attackers to gain unauthorized access to connected devices and confidential data. Which of the following is considered a major security challenge in IoT systems?
- A Electromagnetic interference in transmission lines
 - B Limited bandwidth in communication channels
 - C Weak authentication mechanisms in connected devices .
 - D Voltage fluctuations in power supply circuits
- 6 An embedded system requires a regulated +5V DC supply for a microcontroller circuit. The available input supply is +12V DC. Which voltage regulator IC is most suitable for this application?
- A LM7805
 - B LM7812
 - C LM7912
 - D LM317
- 7 Which IoT layer is primarily responsible for analyzing and processing the collected data?
- A Perception Layer
 - B Transport Layer
 - C Processing Layer
 - D Application Layer

- 8 What is the primary purpose of the I2C peripheral in a microcontroller?
- A To provide high-power AC output for external devices
 - B To convert analog sensor signals directly into digital outputs without external circuitry
 - C To increase the clock frequency of the microcontroller during data processing
 - D To enable serial communication between the microcontroller and multiple peripheral devices using two-wire communication
- 9 Which of the following best defines **Fused Deposition Modeling (FDM)** in 3D printing technology?
- A A manufacturing process that uses ultraviolet light to cure liquid resin layer by layer
 - B A machining technique that removes material from a solid block using rotating cutting tools
 - C A fabrication method that forms objects by compressing powdered metal at high temperature
 - D A process that creates objects by depositing melted thermoplastic material layer by layer
- 10 A manufacturing company plans to produce a large number of identical plastic casings for an embedded electronic device. The production process involves melting plastic material and injecting it into a mold cavity to obtain the required shape. Which manufacturing process is described in this scenario?
- A CNC Machining
 - B Injection Molding
 - C Fused Deposition Modeling
 - D Laser Cutting
- 11 In a product prototyping laboratory, an engineer uses a Stereolithography (SLA) 3D printer to manufacture a high-precision electronic enclosure prototype. Which type of material is primarily used in SLA 3D printing technology?
- A Photosensitive liquid resin
 - B Thermoplastic filament
 - C Metal powder
 - D Ceramic composite sheets

- 12 Which of the following is NOT typically considered a step in the Design Test Quality Cycle?
- A Design and development of the system
 - B Testing and validation of system performance
 - C Quality evaluation and improvement
 - D Random selection of electronic components
- 13 What is the primary purpose of standards, certification, and documentation in electronic design?
- A To increase the manufacturing cost of electronic products
 - B To ensure product safety, reliability, regulatory compliance, and proper technical communication
 - C To eliminate the need for testing and validation procedures
 - D To guarantee that all electronic products operate using identical circuit designs
- 14 Which of the following is an example of CAD software commonly used for engineering drawings in electronic and mechanical design?
- A MATLAB
 - B Proteus ISIS
 - C AutoCAD
 - D Keil μ Vision
- 15 Which of the following correctly identifies the nature of these two tasks?
- A Both airbag deployment and navigation updates have soft deadlines
 - B Airbag deployment has a hard deadline, while navigation updates have soft deadlines
 - C Airbag deployment has a soft deadline, while navigation updates have hard deadlines
 - D Both airbag deployment and navigation updates have hard deadline

[Total - 30 marks]

Part B - Essay

01)

- a) Explain the importance of the **identification of the need** stage in electronic product development. [03]
- b) Describe the activities involved in the Conceptual Design and Detail Design stages of the electronic product design flow. [06]
- c) Differentiate between Alpha Testing and Beta Testing in electronic product validation. [04]
- d) You are supposed to develop a smart wearable health monitoring device for elderly patients. Discuss how you would incorporate the electronic product design flow from identifying user requirements up to certification before releasing the product to the market. [07]

[Total - 20 marks]

02)

- a) Explain the difference between a breadboard prototype and a Printed Circuit Board (PCB) in electronic circuit development. [04]
- b) Describe the main stages involved in the PCB design process from schematic capture to Gerber file generation. [04]
- c) Discuss the importance of PCB design considerations such as signal integrity, thermal management, and EMI/EMC in electronic systems. [04]
- d) Your team is developing a compact IoT-based environmental monitoring device that operates continuously in an industrial environment. Design a suitable PCB layout strategy for the device by considering PCB material selection, component placement, routing techniques, and appropriate PCB testing methods to ensure reliable and efficient operation. [08]

[Total - 20 marks]

03)

- a) Define the Internet of Things (IoT) and explain the main components of an IoT-enabled device. [03]
- b) Describe the four layers of an IoT system architecture and state the function of each layer. [04]
- c) Discuss the major challenges faced in IoT implementation with special reference to security, interoperability, and scalability. [03]
- d) Your company plans to develop an IoT-based smart factory monitoring system to supervise machine temperature, energy consumption, and worker safety in real time. Design a suitable architecture for the system by considering the integration of sensors, connectivity technologies, cloud processing, and user applications. Also evaluate the important factors required to ensure reliable, secure, and efficient operation of the system. [05]

[Total - 15 marks]

- 04) a) Briefly list three essential types of tests performed during electronic design testing and quality assurance. [03]
- b) Describe the purpose and importance of a design specification document in electronic design. [02]
- c) Explain how proper documentation practices can contribute to successful electronic design testing and quality assurance. [04]
- d) Evaluate the role of environmental testing and reliability testing in ensuring the long-term performance, reliability, and customer satisfaction of electronic products. [06]

[Total - 15 marks]

Annex I - MCQ Answer Sheet

Student ID :

- *Instruction : Shade the correct letter using a pencil.*

1. ☐ A ☐ B ☐ C ☐ D
2. ☐ A ☐ B ☐ C ☐ D
3. ☐ A ☐ B ☐ C ☐ D
4. ☐ A ☐ B ☐ C ☐ D
5. ☐ A ☐ B ☐ C ☐ D
6. ☐ A ☐ B ☐ C ☐ D
7. ☐ A ☐ B ☐ C ☐ D
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9. ☐ A ☐ B ☐ C ☐ D
10. ☐ A ☐ B ☐ C ☐ D
11. ☐ A ☐ B ☐ C ☐ D
12. ☐ A ☐ B ☐ C ☐ D
13. ☐ A ☐ B ☐ C ☐ D
14. ☐ A ☐ B ☐ C ☐ D
15. ☐ A ☐ B ☐ C ☐ D



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Semester 4 First Sit - Final Examination 2026

Batch : 07

Module Code: EE2326	Module Title: Analog Circuit Design
Date: 28/05/2026	Duration: 03 hours
Examiner	Ms. Gayani Jayangi

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of 2 Parts. **Part A** contains 15 MCQ questions and **Part B** contains 4 essay type questions. **You should answer all questions.***
- *In **Part A**, you must indicate the correct answer on the MCQ answer sheet given in Annex I and attach to your answer script. Each question carries 2 marks.*
- *In **Part B**, the marks allocated to each question are listed in the column on the far right. The final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*

Part A - MCQ

- 1 Which statement best distinguishes an analog circuit from a digital circuit?
 - A Analog circuits operate using continuously varying signals, whereas digital circuits operate using discrete signal levels.
 - B Analog circuits process information only in binary form, whereas digital circuits process continuously varying signals.
 - C Analog circuits are designed exclusively for amplification purposes, whereas digital circuits are designed exclusively for switching operations.
 - D Analog circuits operate only with alternating current signals, whereas digital circuits operate only with direct current signals.

- 2 Which of the following is considered an important factor in analogue circuit design to ensure accurate signal processing?
 - A Increasing the number of logic gates in the circuit.
 - B Restricting the circuit operation to binary voltage levels only.
 - C Maximizing the switching speed between digital states.
 - D Minimizing the effects of noise and signal distortion.

- 3 Minimizing power consumption is an important consideration in analogue circuit design for extending battery life. Which of the following techniques is **NOT** effective for reducing power consumption in an analogue circuit?
 - A Using low-power components and optimized biasing techniques.
 - B Reducing unnecessary current flow within the circuit.
 - C Operating the circuit continuously at maximum power levels regardless of load conditions.
 - D Selecting efficient voltage regulation methods.

- 4 In analogue circuit design, what is the primary purpose of impedance matching between two stages of a circuit?
 - A To maximize power transfer and minimize signal reflection.
 - B To convert analogue signals into digital signals.
 - C To increase the switching speed of the circuit.
 - D To generate binary voltage levels for signal processing.

- 5 What is the primary function of an RF filter in a communication system?
- A To convert analogue signals into digital signals for processing.
 - B To allow only the desired frequency range to pass while attenuating unwanted frequencies.
 - C To amplify all frequency components of an input signal equally.
 - D To generate carrier signals for wireless transmission.
- 6 A band-pass filter is characterized by
- A Passing all frequencies below a certain cutoff frequency.
 - B Passing all frequencies above a certain cutoff frequency.
 - C Attenuating frequencies within a specific range and passing the frequencies outside the range.
 - D Passing frequencies within a specific range and attenuating the frequencies outside the range.
- 7 In an ideal differential amplifier, if equal signals of the same amplitude and phase are applied to both input terminals simultaneously, what will be the output of the amplifier?
- A An amplified output equal to the sum of the two input signals.
 - B A high-frequency oscillating output signal.
 - C Zero output voltage due to common-mode signal rejection.
 - D An output voltage equal to the average of the two input signals.
- 8 An engineer uses an RC high-pass filter in an audio communication system to reduce unwanted low-frequency noise from a microphone signal. Which of the following signals will be most effectively attenuated by the filter?
- A A 5 kHz audio signal containing speech information.
 - B A high-frequency carrier signal used for modulation.
 - C A 50 Hz hum noise from the power supply.
 - D A rapidly changing pulse signal with high-frequency components.

- 9 Which characteristic best describes the operation of a band-stop (notch) filter?
- A It attenuates a specific range of frequencies while allowing frequencies outside that range to pass.
 - B It allows only a specific range of frequencies to pass while attenuating all others.
 - C It amplifies signals within a selected frequency range without attenuation.
 - D It blocks all frequencies below a specified cutoff frequency.
- 10 Why is the Butterworth filter commonly preferred in many analogue signal processing applications?
- A It produces the sharpest possible cutoff with significant passband ripple.
 - B It amplifies all frequency components equally across the spectrum.
 - C It operates only with digital input signals and binary outputs.
 - D It provides a maximally flat frequency response in the passband without ripple.
- 11 An engineer designs a first-order active low-pass filter for an audio system to remove high-frequency noise from a music signal. When the input frequency becomes much higher than the filter's cutoff frequency, what will happen to the output signal according to the filter transfer function?
- A The output signal amplitude will decrease significantly.
 - B The output signal amplitude will remain unchanged for all frequencies.
 - C The output signal amplitude will increase with increasing frequency.
 - D The filter will amplify only the noise components of the signal.
- 12 An engineering student uses Computer Aided Simulations (CAS) to evaluate the performance of an analogue circuit before hardware implementation. Which of the following represents a major limitation of CAS?
- A CAS completely eliminates the need for mathematical analysis during circuit design.
 - B Simulation results may differ from practical circuit behavior due to idealized component models and real-world uncertainties.
 - C CAS can only be used for digital circuits and not for analogue systems.
 - D CAS automatically guarantees an error-free hardware implementation.

- 13 An engineer examines a commercially available electronic device to identify its circuit configuration, operating principles, and component functions in order to develop a compatible design improvement. This process is an example of
- A Signal modulation.
 - B Impedance matching.
 - C Forward error correction.
 - D Reverse engineering.
- 14 Imagine that you are supposed to test the response of an RC circuit by applying a step input voltage and observing how the output voltage changes with time using an oscilloscope. Which type of analysis is primarily being performed?
- A Time domain analysis to study the circuit response as a function of time.
 - B Frequency domain analysis to evaluate the response at different frequencies.
 - C Impedance matching analysis to maximize power transfer within the circuit.
 - D Fourier analysis to convert time-varying signals into frequency components.
- 15 During the troubleshooting of a digital circuit, a student uses a logic probe to test the output of a logic gate. What is the primary purpose of the logic probe in this situation?
- A To measure the exact frequency response of the digital circuit.
 - B To amplify weak digital signals for transmission.
 - C To determine whether a digital signal is at a logic HIGH or logic LOW state.
 - D To convert analogue signals into digital signals for processing.

[Total - 30 marks]

Part B - Essay

- 01) A wireless communication company is developing a high-frequency RF communication module for a modern embedded system. As an electronics engineer, you are required to analyze several important RF design considerations related to the system. Answer the following questions.

- a) Explain why impedance matching is important in high-frequency RF circuits. Describe two techniques used for impedance matching. [03]
- b) Discuss the role of transmission lines in RF circuits and compare any two common types of transmission lines used in RF design. [04]
- c) Explain how electromagnetic interference (EMI) can affect RF circuit performance. Describe two methods used to reduce EMI in high-frequency systems. [04]
- d) Describe the importance of RF measurements in circuit analysis. Explain the functions of:
 - i) Vector Network Analyzer (VNA)
 - ii) Spectrum Analyzer

[04]

[Total - 15 marks]

- 02) An electronics company is developing a smart monitoring and control system using analogue comparators for industrial automation applications. As an electronics engineer, answer the following questions related to analogue comparator circuits.

- a) Explain the operating principle of an analogue comparator and describe the function of the inverting and non-inverting input terminals. [04]
- b) Discuss four important specifications of an analogue comparator and explain their significance in practical circuit design. [04]
- c) Compare the LM311 and LM393 comparator ICs with respect to their structure and typical applications. [04]
- d) A factory requires an automatic warning system that turns ON an LED when the temperature sensor voltage exceeds a preset reference voltage. Explain how an analogue comparator can be used to implement this system, clearly describing:
 - i) the comparator inputs
 - ii) the reference voltage
 - iii) the output operation of the LED indicator

[08]

[Total - 20 marks]

- 03) An electronics engineer is designing active filter circuits for a signal conditioning system used in an industrial monitoring application. Answer the following questions related to active filters and filter optimization techniques.
- a) Explain the main advantages of active filters over passive filters. Identify the major components used in active filter circuits. [03]
 - b) Discuss the following filter performance characteristics and explain their importance in filter design: [04]
 - i) Frequency response
 - ii) Roll-off
 - iii) Stopband attenuation [06]
 - c) Compare Butterworth, Tschebyscheff, and Bessel filters in terms of their frequency response characteristics and typical applications. [03]
 - d) A biomedical engineer is designing an ECG signal processing system that requires accurate waveform reproduction with minimal signal distortion and constant group delay. [04]
 Recommend the most suitable filter optimization type for this application and justify your answer based on its characteristics and practical performance.
- [Total - 20 marks]**
-
- 04) a) Briefly describe the concept of reverse engineering in the context of electronic circuit design. List three potential benefits and three ethical considerations associated with reverse engineering electronic products. (Use two sentences to describe the concept and three sentences to describe the ethical considerations.) [05]
- b) Explain the role of computer-aided simulation (CAS) tools in the reverse engineering process and how can CAS tools assist engineers in understanding the functionality and performance of an unknown circuit? (Use three sentences for the explanation.) [03]
- c) Imagine you are tasked with reverse engineering a legacy analog audio amplifier with limited documentation. Outline a systematic approach you would take to analyze and understand the circuit's operation. (Use a maximum of seven bullet points with one sentence each.) [07]
- [Total - 15 marks]**

Annex I - MCQ Answer Sheet

Student ID :

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15. ☐ A ☐ B ☐ C ☐ D



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
**BSc. Hons. (Eng.) in Automotive/ Electronic and Telecommunication/ Mechanical/
Mechatronic Engineering**
Semester 6 First Sit - Final Examination 2026

Batch: 06

Module Code: EE3324	Module Title: Control Systems
Date: 21 May 2026	Duration: 03 Hours
Examiner 1: Mr. Randeera Liyanage	

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of four (4) questions and 5 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and log-linear sheets for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*

- Q1 i)** Using mathematical modeling, derive the transfer function for the following electronic circuit illustrated in **Figure 1**. Following this, substitute the given system parameters and express the resulting transfer function in standard form. [05]
(Use $R = 14 \Omega$; $C = 100 \mu\text{F}$; $L = 10 \text{ mH}$)

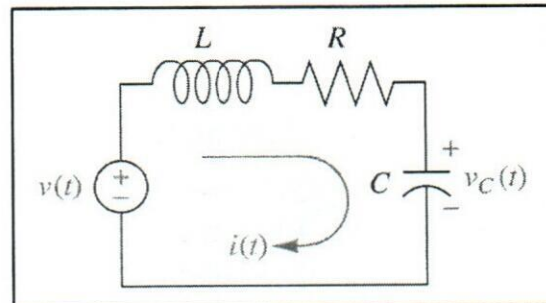


Figure 1

- ii) Based on the transfer function obtained in Part (i), construct the corresponding pole-zero diagram and comment on the system's stability with respect to the pole locations in the diagram. Subsequently, characterize the nature of the system's oscillations. [06]
- iii) Calculate the angle (θ) that defines the line of constant damping ratio within the pole-zero diagram constructed in Part (ii). Hence describe the effects of varying the damper's damping coefficient on the system's response. (Use two sentences for the description.) [02]

$$\cos(\theta) = \zeta$$

- iv) Simplify the block diagram given in **Figure 2**. [12]

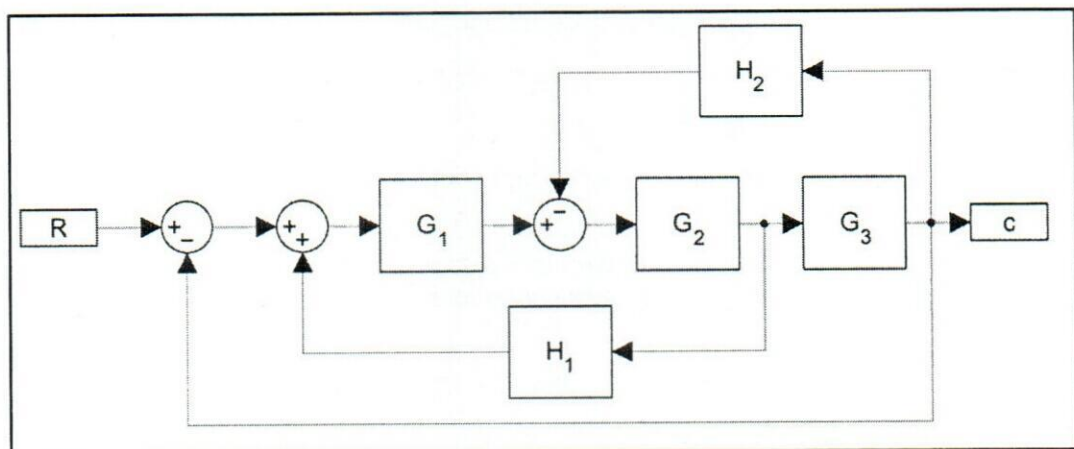


Figure 2

Total [25]

- Q2. i) Determine the stability of the system given by the following characteristic equation using the Routh-Hurwitz stability criterion. Hence, state the number of poles that are in the right-hand side, left-hand side and in the imaginary axis. [05]

$$s^6 + s^5 + 5s^4 + s^3 + 2s^2 - 2s - 8 = 0$$

- ii) a) Determine the open loop transfer function expression of the spring-mass damper system shown in Figure 3. [02]

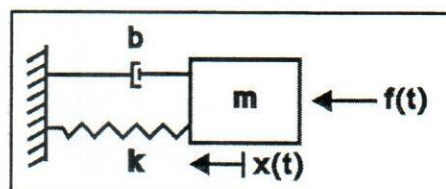


Figure 3

- b) Calculate the steady state error (e_{ss}), percentage overshoot (%OS), rise time (T_r) and settling time (T_s) of the spring-mass damper system in Part (a) for a unit step input. (Use $m = 1$ kg; $b = 10$ N.s.m⁻¹; $k = 20$ N.m⁻¹) [08]

$$T_r = \frac{1.8}{\omega_n} \quad ; \quad T_s = \frac{4}{\zeta \omega_n} \quad ; \quad \%OS = e^{-\left(\frac{\zeta \pi}{\sqrt{1-\zeta^2}}\right)} \times 100$$

$$E(s) = \frac{R(s)}{1 + G(s)} \quad ; \quad e_{ss} = \lim_{s \rightarrow 0} s \cdot E(s)$$

- c) To improve the system response, a PID controller is introduced to the system in Part (b). Draw the resulting closed loop system block diagram, obtain an expression for the unity feedback closed loop transfer function, and calculate the resulting steady state error (e_{ss}), percentage overshoot (%OS), rise time (T_r) and settling time (T_s) for a unit step input. [10]

(Initial values of the controller are $K_P = 300$; $K_I = 0$; $K_D = 0$)

$$CLTF = \frac{G(s)}{1 + H(s) G(s)}$$

Total [25]

- Q3. i) Describe the importance of Bode plots in the design of a control system and how this technique contributes to achieving the desired system performance. (Use two sentences for the description.) [02]
- ii) The task is to design a gain compensator for an industrial machine consisting of a motor and a load, as represented by the block diagram in Figure 4.

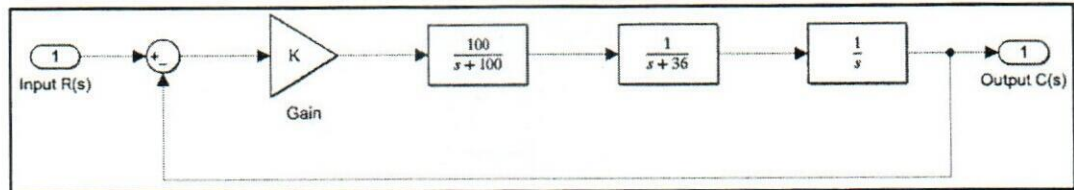


Figure 4

- a) Assuming an initial value of $K = 1$, determine the open-loop transfer function $G(s)$ of the system. Subsequently, obtain the corresponding frequency response (magnitude and phase) for this uncompensated system. [04]
- b) Using the frequency response obtained in part (a), plot the Bode diagram for the range of angular frequencies (ω) between 0.01 rad.s^{-1} and 100 rad.s^{-1} on the provided log-linear sheet. (Attach the completed Bode diagram to the answer script.) [10]
- c) Determine the corresponding gain margin and phase margin for the uncompensated system based on the Bode diagram. [02]
- $GM = 0 - x \quad ; \quad PM = \Phi + 180$
- d) Design a gain compensator by determining the gain value (K) of the system to achieve a transient response with a 9.5 % overshoot for a unit step input signal. [07]

$$\zeta = \frac{-\ln\left(\frac{\%OS}{100}\right)}{\sqrt{\pi^2 + \ln\left(\frac{\%OS}{100}\right)^2}} \quad ; \quad \Phi_M = \tan^{-1}\left(\frac{2\zeta}{\sqrt{-2\zeta^2 + \sqrt{1 + 4\zeta^4}}}\right)$$

$$20 \log(K) = \text{Gain}$$

Total [25]

- Q4.** i) Microcontroller-based systems often integrate digital control with analog sensors and actuators. This introduces compatibility challenges. Discuss two of these challenges and their corresponding corrective mechanisms. (*Each challenge and its solution should be described in two clear sentences.*) [04]
- ii) An analog controller is described by the following transfer function. The design team has chosen to implement this controller digitally with an initial sampling period of 0.25 s.
- a) Apply the Tustin transformation and obtain the equivalent Z-transfer function of the digital controller. [03]

$$s = \frac{2z - 1}{Tz + 1}$$

- b) Express the Z-transfer function obtained in part (a) as a difference equation using the differentiating in time domain property. [02]
- c) Plot the unit step response of the digital controller for a period of $0 \leq t \leq 3$ seconds. [06]
- d) Determine the output equation $y(t)$ of the analogue controller for a unit step input using inverse Laplace Transform. [04]

$$1 \xleftrightarrow{\mathcal{L}} \frac{1}{s} \quad ; \quad 1 - e^{-\alpha t} \xleftrightarrow{\mathcal{L}} \frac{\alpha}{s(s + \alpha)}$$

- e) Using the analogue output equation obtained in part (d), plot the unit step response of the original analogue controller $G(s)$ for $0 \leq t \leq 3$ seconds. [06]

Total [25]

End of the Question Paper



Faculty of Engineering & Technology Department of Electrical and Electronic Engineering BSc. Hons. (Eng.) in Electronic and Telecommunication Engineering Semester 6 First Sit - Final Examination 2026 Batch: 06	
Module Code: EE3327	Module Title: Electronic Instrumentation
Date: 18th May 2026	Duration: 03 hours (0900-1200h)
Examiner 1:	Srimal Punchihewa
Examiner 2:	Dr Keerthi Gunawickrama

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed unless specified.
- This paper consists of five (05) questions and three (03) pages. Answer all questions.
- The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Write clearly and legibly. Use a blue or black pen only.
- Write your student number on all sheets.
- Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.

- Q1** i) a) If an analog multimeter is used in a laboratory for measurement of voltage, [05]
how should the observer look at the pointer against the scale in the background to take the measurement?
- Describe briefly the error that would occur if the measurement is done incorrectly.
- b) Briefly describe systematic errors in a measurement. Can these errors be [05]
reduced by taking the average of multiple measurements. Briefly describe why or why not.
- c) A student takes three measurements: 4.62 g/mL, 4.63 g/mL, 4.62 g/mL. The [04]
true value is 6.82 g/mL. Is this precise? Is it accurate?
- ii) Briefly define Measured Value, True Value, and Error. [06]
- Total [20]**
- Q2.** i) Compare and contrast between Direct Method and Indirect Method of [05]
Measurement.
- ii) Compare and contrast between Deflection methods and Comparison methods [05]
used in Direct Method of Measurement.
- iii) Draw a clearly labelled block diagram indicating functional elements of an [10]
instrument.
- Total [20]**
- Q3.** i) When the output of a sensor is digitized, aliasing is observed. Briefly describe the [03]
reasons for aliasing.
- ii) The output of a sensor is converted into a 3-bit digital signal. If the dynamic [04]
range of the sensor output is 10 Volts, determine the quantization size. Show all the steps of your calculation.
- iii) a) Briefly describe the operation of a Resistance Temperature Detector (RTD). [04]
b) If a RTD is specified as 100 Ω , state the meaning of it. [02]
- iv) Briefly describe the offset, non-linearity and dynamic error of a non-ideal sensor [04]
- v) Briefly describe Sensor Fusion, by stating its meaning. [03]
- Total [20]**

- Q4. i) a)** In the case of an ideal passive low pass filter, the changeover from the passband to stopband at the cutoff frequency is sharp and sudden. [04]

However, in the case of a real passive low pass filter, the changeover is gradual and exhibits a roll off.

Briefly describe this roll off, by citing the value of the gradient of this roll off and the meaning of it.

- b)** Compare and contrast the transition from passband to stopband for a real passive first order low pass filter and a real passive second order low pass filter. [04]
- ii)** Discuss briefly a real active bandpass filter illustrating its typical circuit diagram and its Gain-frequency and Phase-frequency plots, mentioning important parameters and their typical values. [05]
- iii)** Discuss briefly an active low pass filter with amplification with the aid of a typical circuit diagram. [07]

Derive DC gain of this filter stating all the assumptions. Assume an Ideal Operational Amplifier

Total [20]

- Q5. i) a)** In Data Acquisition, real world physical conditions are converted to Digital numeric values that can be manipulated by a computer. [05]

Discuss briefly this conversion process with the help of a suitable block diagram.

- b)** In Data Acquisition systems, sensors are used to convert physical parameters to electrical signals and signal conditioning circuitry are used immediately after that. [05]

Discuss briefly the necessity of signal conditioning circuitry especially considering the bandwidth of sensor output electrical signals and requirement to satisfy Nyquist criterion.

- ii)** In analog to digital conversion process of a Data Acquisition system, should the number of quantization levels be compromised? Discuss briefly. [05]
- iii)** Data Acquisition systems use database systems as opposed to file-based systems. Discuss briefly advantages and disadvantages of such usage. [05]

Total [20]

END OF EXAMINATION PAPER



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc. Hons. (Eng.) in Electronic & Telecommunication /
Mechatronics Engineering
Semester 6 First Sit - Final Examination 2026
Batch : 06

Module Code: EE3322	Module Title: Digital Signal Processing
Date: 14th May 2026	Duration: 3 hrs
Examiner :	Ms.Bashini Premathilake

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of Five (5) questions and 6 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
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Q1

- i) Define the following system properties. Provide suitable examples.

a) Causal system

[02]

b) Time-invariant system

[02]

- ii) Determine whether the following system is **causal** and **time-invariant**. Justify your answers.

$$T[x(n)] = an^2x(n-1)$$

[04]

- iii) Given the sequence $x(n) = \{3, -1, 4, 2, 0, -2\}$ sketch the following sequences.

a) $x_1(n) = x(n-2)$

b) $x_2(n) = x(n+3)$

c) $x_3(n) = x(-n)$

d) $x_4(n) = x(1-n)$

e) $x_5(n) = x(-n-1)$

[05]

- iv) Two sequences $x(n)$ and $h(n)$ are given below.

$$x(n) = \{2, -1, 0, 3\}$$

$$h(n) = \{-3, 1, 2\}$$

a) Sketch $x(n)$ and $h(n)$.

b) Compute the convolution $y(n) = x(n) * h(n)$ using the graphical method.

c) Sketch the output $y(n)$.

[07]

Total [20]

Q2.

- i) Given $x_1(t)$ and $x_2(t)$, determine their Laplace transforms, Regions of Convergence (ROC), pole-zero plots and comment on the stability and causality of the systems with justification.

a) $x_1(t) = \delta(t) - 6e^t u(t) + 6e^{-2t} u(t)$

[06]

b) $x_2(t) = e^{2t} u(-t) + e^{-3t} u(-t)$

[06]

- ii) A system is described by the differential equation given in (1).

$$\frac{d^2 y(t)}{dt^2} + 5 \frac{dy(t)}{dt} + 4 y(t) = \frac{dx(t)}{dt} - 3x(t) \quad (1)$$

- a) Using the Laplace transform, determine the transfer function $H(s)$ of the system.
- b) Determine the poles and zeros of the system.
- c) Sketch the pole-zero plot.

[04]

- iii) Compute the 4-point DFT of $x(n)$ given below using the matrix method. Show all steps clearly. [04]

$$x(n) = \{2, 1, -1, -2\}$$

↑

Total [20]

- Q3. i) State the conditions for causality and stability of a discrete-time system in terms of the Region of Convergence (ROC) in the z -domain. [02]
- ii) Using the definition of the Z-transform, determine the Z-transform and ROC of the following sequences.

a) $x_1(n) = \left(\frac{2}{3}\right)^n u(-n)$ [03]

b) $x_2(n) = \left(\frac{1}{5}\right)^n u(n) - 3^n u(-n-1)$ [05]

- iii) Determine the inverse Z-transform of $X(z)$ given in (2) using the long division method, assuming the system is **anti-causal**. Hence, obtain four non-zero samples of the time-domain sequence $x(n)$. [05]

$$X(z) = \frac{(1 + 4z^{-1})}{(1 - 3z^{-1} + 2z^{-2})} \quad (2)$$

- iv) The system function of a LTI system $H(z)$ is given in (3). Assuming the system is **stable**, determine the impulse response $h(n)$ and the Region of Convergence (ROC) using partial fraction method. [05]

$$H(z) = \frac{(5 - z^{-1})}{(1 - 2.5z^{-1} + z^{-2})} \quad (3)$$

Total [20]

- Q4. i) a) State three characteristics of a Butterworth filter. [03]
- b) Design a digital Butterworth low pass filter using the bilinear transformation with the following specifications. ($T = 1$ sec).

$$0.85 \leq |H(e^{j\omega})| \leq 1 \quad ; \quad 0 \leq \omega \leq \pi/3$$

$$|H(e^{j\omega})| \leq 0.05 \quad ; \quad 3\pi/4 \leq \omega \leq \pi$$

[07]

- ii) a) Explain linear phase FIR filters. State two aspects of zero placement in the z -plane that ensure linear phase characteristics. [04]

- b) Determine the impulse response $h(n)$ of an FIR filter of length $N=5$ using the Hamming window method. The desired frequency response is given by,

$$H_d(e^{j\omega}) = \begin{cases} e^{-j2\omega} & ; \quad -\pi/3 \leq \omega \leq \pi/3 \\ 0 & ; \quad \text{Otherwise} \end{cases} \quad [06]$$

Total [20]

Q5.

- i) Perform the filter realizations and write the difference equations using Direct Form I and Direct Form II Implementation for the transfer function $H(z)$ given in (4). [08]

$$H(z) = 2 + \frac{z}{(z - 0.3)} - \frac{0.5}{(z - 0.8)} \quad (4)$$

- ii) Factor the system function given in (5) into first-order sections and realize it using the cascade structure. [06]

$$H(z) = \frac{(6 - z^{-1} - 15z^{-2})}{(1 - 4.5z^{-1} - 9z^{-2})} \quad (5)$$

- iii) Consider an FIR system with the impulse response,

$$h[n] = \{2, 1/3, 0, 1/3, 2\}$$

↑

- Realize the FIR filter using the direct form structure.
- Determine whether the filter exhibits linear phase characteristics. If so, identify the type of linear phase FIR filter.
- Using the symmetry property, obtain a realization with the minimum number of multipliers.

[06]

Total [20]

End of the Question Paper

Useful Formulas

Laplace transform :

$$L[x(t)] = X(s) = \int_{-\infty}^{\infty} x(t)e^{-st} dt$$

Z Transform :

$$X(z) = \sum_{n=-\infty}^{\infty} x(n)z^{-n}$$

Some Common z-Transform Pairs

	Signal, $x(n)$	z-Transform, $X(z)$	ROC
1	$\delta(n)$	1	All z
2	$u(n)$	$\frac{1}{1 - z^{-1}}$	$ z > 1$
3	$a^n u(n)$	$\frac{1}{1 - az^{-1}}$	$ z > a $
4	$na^n u(n)$	$\frac{az^{-1}}{(1 - az^{-1})^2}$	$ z > a $
5	$-a^n u(-n - 1)$	$\frac{1}{1 - az^{-1}}$	$ z < a $
6	$-na^n u(-n - 1)$	$\frac{az^{-1}}{(1 - az^{-1})^2}$	$ z < a $
7	$(\cos \omega_0 n)u(n)$	$\frac{1 - z^{-1} \cos \omega_0}{1 - 2z^{-1} \cos \omega_0 + z^{-2}}$	$ z > 1$
8	$(\sin \omega_0 n)u(n)$	$\frac{z^{-1} \sin \omega_0}{1 - 2z^{-1} \cos \omega_0 + z^{-2}}$	$ z > 1$
9	$(a^n \cos \omega_0 n)u(n)$	$\frac{1 - az^{-1} \cos \omega_0}{1 - 2az^{-1} \cos \omega_0 + a^2 z^{-2}}$	$ z > a $
10	$(a^n \sin \omega_0 n)u(n)$	$\frac{az^{-1} \sin \omega_0}{1 - 2az^{-1} \cos \omega_0 + a^2 z^{-2}}$	$ z > a $

$$1 + A + A^2 + A^3 + \dots - \infty = \sum_{n=0}^{\infty} A^n = \frac{1}{1-A}$$

Order of the Butterworth filter N,

$$N \geq \frac{\log\left(\frac{\lambda}{\varepsilon}\right)}{\log\left(\frac{\Omega_s}{\Omega_p}\right)}$$

Cut off frequency,

$$\Omega_c = \frac{\Omega_p}{\frac{1}{\varepsilon^{\frac{1}{N}}}}$$

Butterworth Filter – Denominator Polynomials

N	Denominator of H(S)
1	(S + 1)
2	(S ² + √2 S + 1)
3	(S + 1)(S ² + S + 1)
4	(S ² + 0.76537S + 1)(S ² + 1.84776S + 1)
5	(S + 1)(S ² + 0.61803S + 1)(S ² + 1.61803S + 1)
6	(S ² + 1.931855S + 1)(S ² + √2 S + 1)(S ² + 0.51764S + 1)
7	(S + 1)(S ² + 1.80194S + 1)(S ² + 1.247S + 1)(S ² + 0.445S + 1)

$$h_d(n) = \frac{1}{2\pi} \int_{-\pi}^{\pi} H_d(e^{j\omega}) e^{j\omega n} d\omega$$

$$W_H(n) = 0.54 - 0.46 \cos\left(\frac{2\pi n}{N-1}\right); 0 \leq n \leq N-1$$

$$H(z) = z^{\frac{-(N-1)}{2}} \left\{ h(0) + \sum_{n=1}^{\frac{N-1}{2}} h(n)[z^n + z^{-n}] \right\}$$



Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc. Hons in Engineering in Mechatronics Engineering
Semester 6 First Sit - Final Examination 2026

Batch : 6

Module Code: EE3328	Module Title: Virtual Instrumentation
Date: 23-04-2026	Duration: 3 Hours
Examiner 1:	Dr Keerthi Gunawickrama
Examiner 2:	Dr Dimuthusiri Suraweera

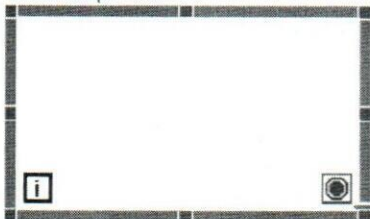
Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of four (4) questions and 5 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet and additional sheets for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*

- Q1**
- Define what is a Virtual Instrument? [5]
 - State primary purpose of the **Front Panel** as well as the **Block Diagram** in LabVIEW. [5]
 - Explain the concept of **Data Flow Execution** in LabVIEW. How does it contrast fundamentally with control-flow execution found in traditional text-based programming languages like C or Python? [5]
 - What are the benefits of using LabVIEW for Hardware-in-the-Loop (**HIL**) testing. [5]
 - Explain the use of Rapid Control Prototyping (**RCP**) in LabVIEW via a conceptual example. [5]

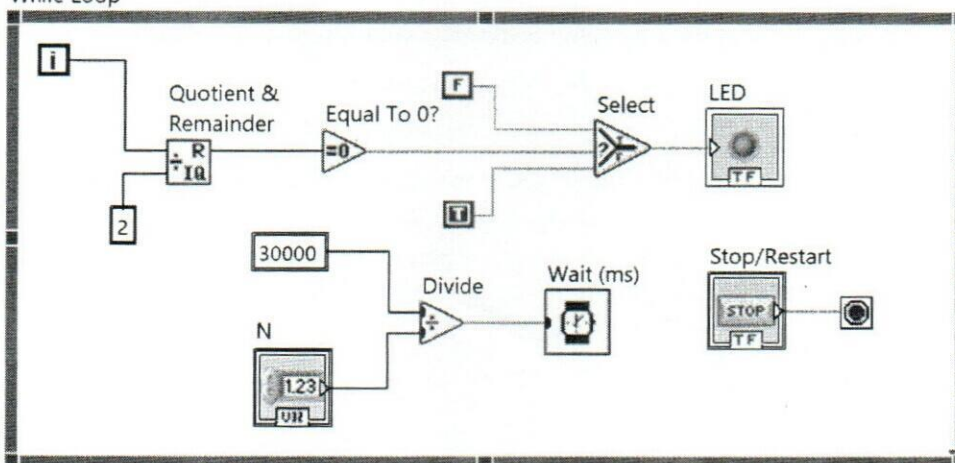
- Q2**
- Describe how a **While Loop** functions in LabVIEW. In your answer, clearly explain the purpose and operation of the following two components: [5]
 - The **Iteration Terminal** (labeled as **i**)
 - The **Conditional Terminal** (which can be configured as a red **Stop If True** button or a green **Continue If True** arrow)

While Loop



- Consider the VI-Block Diagram, based on a while loop, given below.

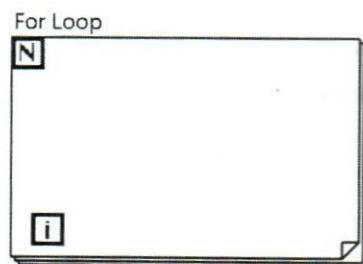
While Loop



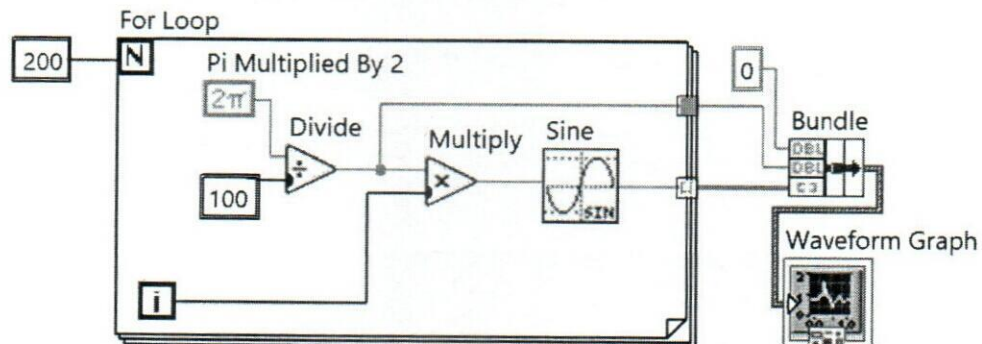
- Describe the function of each of following nodes: **Quotient & Remainder**, **Equal to 0?**, **Select**, **Divide** and **Wait (ms)**. [5]

- b) Identify the *overall function* of the VI, given in the Block Diagram. [5]
 c) What is the effect on the identified *overall function*, if **N** is set to 30? [5]
 iii) What are the data types that are available in LabVIEW? State the methods used in LabVIEW to indicate the data type that communicated through *wires*? [5]

- Q3 i) Describe how a **For Loop** functions in LabVIEW. In your answer, clearly explain the purpose and operation of the following two components: [5]
- The **Iteration Terminal** (labeled as **i**)
 - The **Count Terminal** (labeled as **N**)



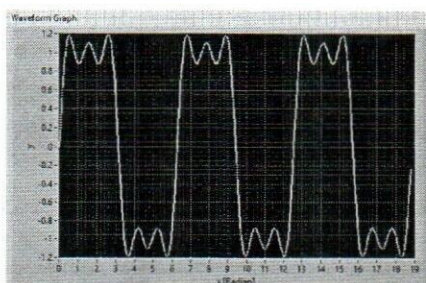
- ii) Consider the block diagram of a VI that displays a Sine wave.



- a) What is the total number of *points* plotted in the Graph? What is the number of points plotted within 0 and 2π (that is, resolution of the X-axis)? [5]
 b) Explain the difference between two tunnel modes; **Last Value** and **Indexing** that appear on the boarder of the loop. [5]
 c) Sketch the output of the Waveform Graph. Label X and Y axes, and indicate the scale values in the respective axes. [5]
 iii) A unity-amplitude square wave $y(t)$ can be approximated by the following sum of three sine waves: [5]

$$y(t) = \frac{4}{\pi} \left\{ \sin(x) + \frac{1}{3} \sin(3x) + \frac{1}{5} \sin(5x) \right\}, \text{ where } x \text{ is in radians}$$

Draw a conceptual VI Block Diagram that evaluates the sum at 300 equally spaced x -values in the range from $x = 0$ to $x = 6\pi$ (i.e. for three cycles of the first sine function in the sum) and then plots the resulting y vs x on a Waveform Graph, whose x -axis is calibrated in radians. If the VI is run, it would produce the front-panel plot shown next.



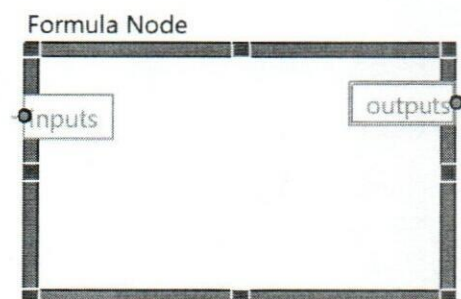
Suggested Nodes: **Sine**, **Compound Arithmetic**, **Pi**

- Q4 i)** Complete the following **Formula Node** to represent the transfer function of a 2nd order system in time domain, given by [5]

$$y(t) = 1 - \frac{e^{-\zeta\omega_n t}}{\sqrt{1 - \zeta^2}} \sin(\omega_d t + \theta)$$

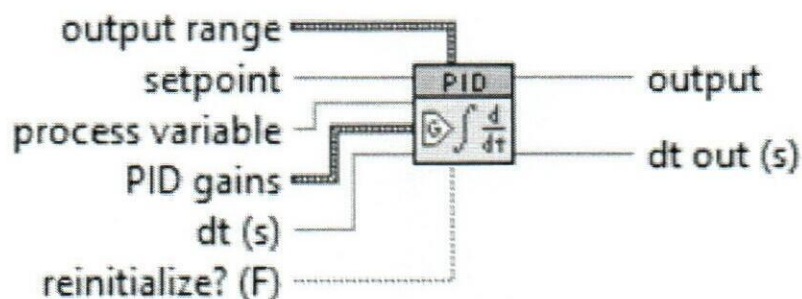
where, $\omega_d = \omega_n \sqrt{1 - \zeta^2}$ and $\theta = \cos^{-1}(\zeta)$

Clearly state the inputs and output variables that correspond to variables given in the preceding formula.



- ii) Explain the function of nodes: **Feedback**, and **Shift Register**. [5]
- iii) Design a conceptual block diagram that implements a unity feedback PID control system. The process being controlled is a 2nd order system and modeled by using a Formula node. [5]

A PID controller node available in LabVIEW is given below.



- iv) a) What are the essential structural nodes, data components, and functions that are needed to build a standard **State Machine** in LabVIEW. [5]
- b) Design a control system for an automated gate at a parking lot entry using standard LabVIEW State Machine architecture. [5]

The system functions based on the following rules:

- **Idle State:** The gate is closed. The system constantly monitors a "**Vehicle Present**" sensor.
- **Open Gate State:** When a vehicle is detected, the gate opens and stays open until a "**Clearance Timer**" completes (outputs a TRUE pulse). Once the timer finishes, the system returns to the **Idle State**.

Sketch the LabVIEW block diagram required to implement this application. Clearly label and show the connection between the 3 essential structural nodes/data types that form the foundational "engine" of a LabVIEW state machine.

In a short paragraph, explain how data flows from one iteration to the next to change states, and identify exactly what logic or function is used to decide whether to stay in the **Idle State** or move to the **Open Gate State**.

--- End of the Question Paper ---



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc. Hons. (Eng.) in Automotive / Civil / Electronic & Telecommunication /
Mechanical / Mechatronics Engineering
Semester 2 First Sit - Final Examination 2026
Batch : 08

Module Code: EE1326	Module Title: Electronics
Date: 04th May 2026	Duration: 3 hrs
Examiner :	Ms.Bashini Premathilake

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of Five (5) questions and 8 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*

Q1 i)

a) Briefly describe the process of stimulated emission of radiation. Illustrate your answer with an energy level diagram. [04]

b) In a certain solid-state laser, an electron in an excited state (E2) undergoes a stimulated transition to the ground state (E1). The emitted photon has a frequency of 5.64×10^{14} Hz. Determine the energy difference E2 - E1 in electron volts (eV). [03]

Given: Planck's constant $h - 6.626 \times 10^{-34}$ J.s

Elementary charge $e - 1.602 \times 10^{-19}$ C

ii)

a) Sketch the energy band diagrams showing valence band, conduction band and forbidden gap for conductors, semiconductors and insulators. [03]

b) Explain intrinsic semiconductors and extrinsic semiconductors with examples. [04]

c) Explain the operating principle of a P-N junction diode under forward bias conditions. Provide a clearly labeled circuit diagram illustrating the applied bias polarity, the depletion region and the direction of majority charge carrier movement. [03]

d) Explain the operating principle of a P-N junction diode under reverse bias conditions. Provide a clearly labeled circuit diagram illustrating the applied bias polarity, the depletion region and the direction of majority charge carrier movement. [03]

Total [20]

Q2. i)

List three applications of a P-N junction diode in electronic circuits. Briefly explain the working principle of one application using a clearly labeled circuit diagram and input/output waveforms. [06]

ii) A silicon diode is connected in a series circuit with a 1 k Ω resistor and a 10V DC power supply. The diode is forward-biased.

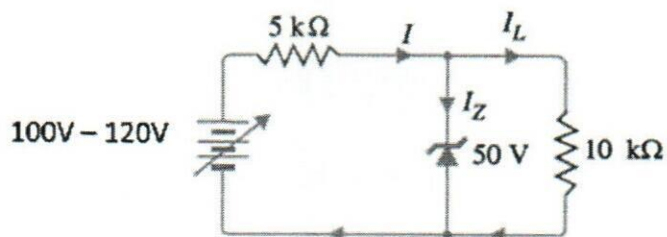
a) Draw the circuit diagram.

b) Assuming the simplified model of a silicon diode with a forward voltage drop of 0.7V, calculate the forward current flowing through the circuit.

c) Calculate the power dissipated by the diode.

d) If the same circuit is connected in reverse bias, what is the expected current? [05]

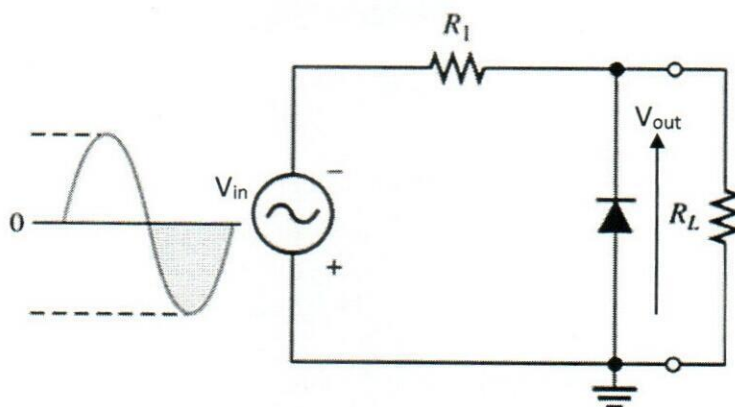
iii)

Refer to **Figure 1** and answer the following questions.**Figure 1**

Determine the maximum and minimum values of the zener diode current (I_Z). Calculate the voltage across $5\text{ k}\Omega$ resistor corresponding to each instance.

[06]

iv)

Refer to **Figure 2** and answer the following questions.**Figure 2**

- What is the name of the circuit shown in **Figure 2**. [01]
- Draw the output waveform (V_{out}) with respect to the input waveform (V_{in}). Assume the diode is ideal. [02]

Total [20]

Q3. i) Refer to **Figure 3** and answer the following questions.

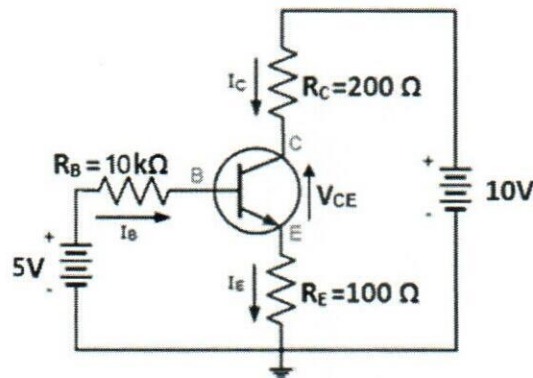


Figure 3

Find

- a) I_B
- b) I_C
- c) I_E
- d) V_{CE}

Take $V_{BE} = 0.7 \text{ V}$ and $\beta = 150$.

[06]

- ii) Refer to **Figure 4** and answer the following questions.

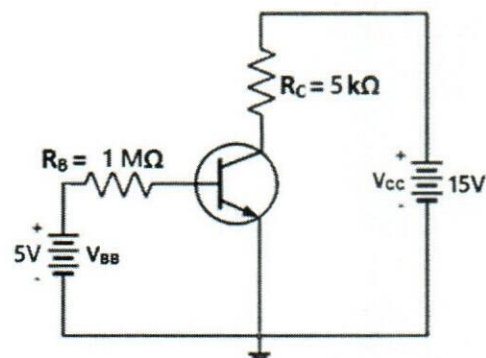


Figure 4

Determine the intercept points of the DC load line on the vertical and horizontal axes of the collector characteristics curves.

[04]

- iii) Refer to **Figure 5** and answer the following questions.

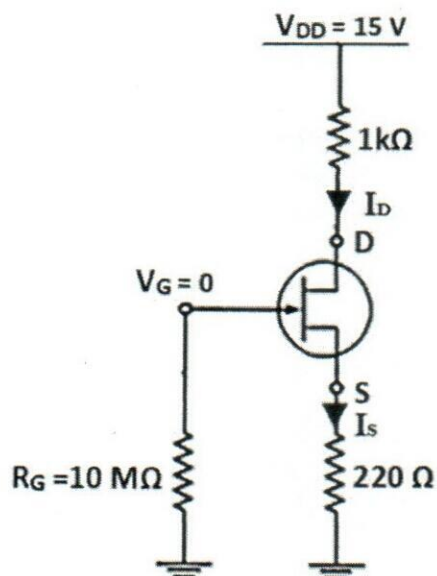


Figure 5

Find

- a) V_S
- b) V_D
- c) V_{DS}
- d) V_{GS}

Take $I_D = 5 \text{ mA}$ and $V_{DD} = 15 \text{ V}$

[06]

- iv) Calculate the drain current I_D when $V_{GS} = -1 \text{ V}$ using Shockley's equation. Given $I_{DSS} = 8 \text{ mA}$ and $V_P = -4 \text{ V}$ for a JFET.

[04]

Total [20]

- Q4. i) Convert $(15.125)_{10}$ to its equivalent binary number. [03]
- ii) Convert the binary number 101001111101001 to its equivalent hexadecimal number. [02]
- iii) Convert the octal number $(407)_8$ to its equivalent binary number. [02]
- iv) Refer to **Figure 6** and answer the following questions.

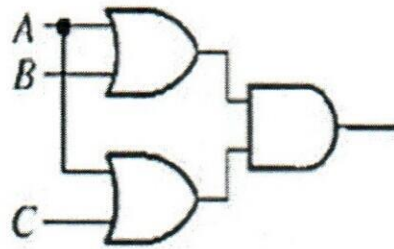


Figure 6

- a) Identify the inputs and output in the logic circuit and develop the truth table. [03]
- b) Draw the Karnaugh map for the output obtained in part (a) and obtain a simplified SOP form. [02]
- c) Draw the simplified logic circuit using basic logic gates. [02]
- v) Refer to **Figure 7** and answer the following questions.

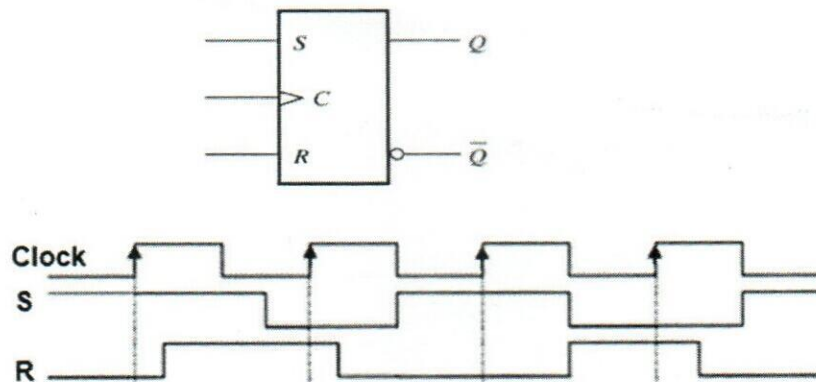


Figure 7

Draw the Q output waveform of the S-R flip flop for the S, R and Clock inputs given. Assume that the flip flop is initially RESET. [03]

- vi) Refer to **Figure 8** and answer the following questions.

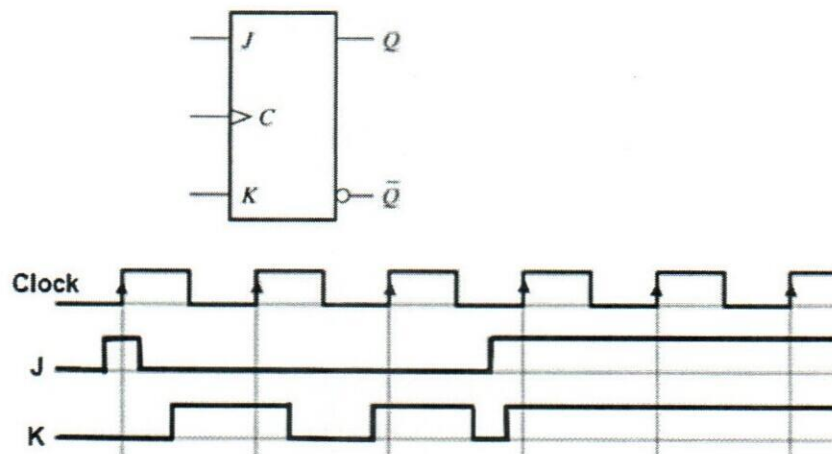


Figure 8

Draw the Q output waveform of the J-K flip flop for the J, K and Clock inputs given. Assume that the flip flop is initially RESET.

[03]

Total [20]

Q5.

- i) List three assumptions of an ideal operational amplifier. [03]
- ii) Draw transfer characteristics of ideal Op-amp and practical Op-amp (V_{out} versus V_d) [03]
- iii) Consider an inverting amplifier circuit constructed using an ideal op-amp. The input resistor R_a is 20 k Ω and the feedback resistor R_f is 100 k Ω .
 - a) Draw the circuit diagram [02]
 - b) Derive an expression for the voltage gain of the inverting amplifier in terms of R_a and R_f . [03]
 - c) If an input voltage of 0.5 V DC is applied, calculate the output voltage V_{out} . [02]
- iv) Refer to **Figure 9** and answer the following questions.

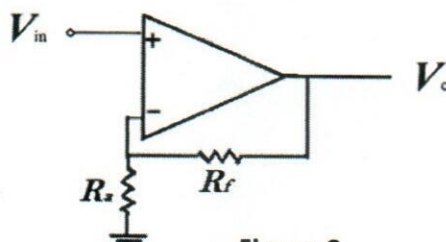


Figure 9

- a) Derive an expression for the voltage gain of the non-inverting amplifier given in **Figure 9**.

[03]

If $R_a = 20 \text{ k}\Omega$, $R_f = 200 \text{ k}\Omega$ and $V_{in} = 400 \text{ mV}$, in the non-inverting amplifier, find

- b) Gain of the amplifier.

[02]

- c) Output voltage.

[02]

Total [20]

End of the Question Paper



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc Hons (Eng) in Mechatronic Engineering – Batch 05
Semester 07 - First Sit - End Semester Examination
April 2026

Module Code	:	ME 4317
Module Title	:	Industrial Automation
Date	:	20 th April 2026
Examiner	:	Eng. MGJP Fernando
Time Allowed	:	03 Hours

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination. No reference materials are allowed.
- This paper consists **FIVE** (05) questions. Answer **ALL** questions.
- Use only the provided answer booklet and additional sheets for your answers. Additional sheets may be requested from the invigilators.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* additional sheets.
- ***Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.***
- ***Do not answer parts of the same question discontinuously in different sheets.***
- If you are unsure about the wording of a question consult the Supervisor or Invigilator, or make reasonable assumptions. Clearly state such assumptions in your answer script.
- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.

MATERIALS REQUIRED

- CINEC answering Booklet & additional sheets

QUESTION 01 [20 MARKS]

[a] Describe the 'Advantages of Machinery'.

[04 Marks]

[b] Classify the following industries according to the Primary, Secondary, and Tertiary Types.

Mining, Bridge Construction, Logistics, Textile, Farming, Warehousing, Fishing, Banking, Cosmetics, Forestry, Digital marketplaces, Smart Wearables

[03 Marks]

[c] What are the X and Y axis of the diagram shown in **Figure 1.1**? By referring the same figure, differentiate the four types of productions shown in the figure.

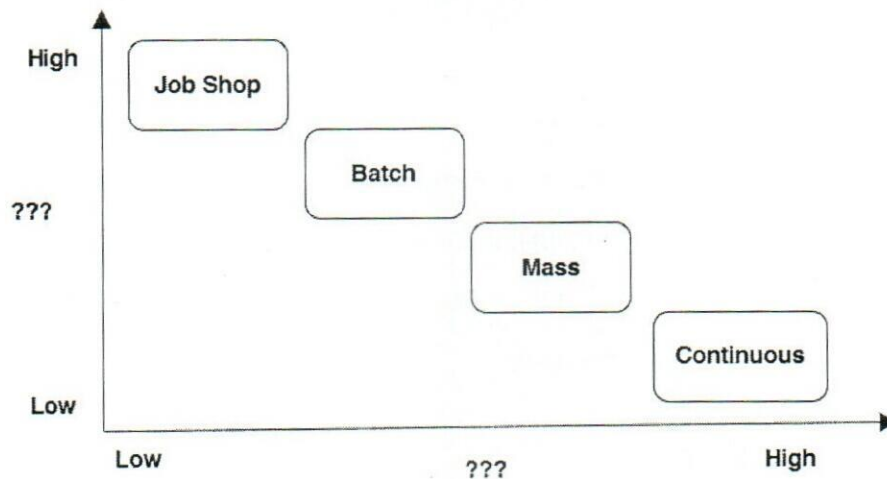


Figure 1.1

[05 Marks]

[d] Illustrate and describe the difference between Fixed Automation, Flexible Automation, and Programmable Automation using a product variety vs volume diagram.

[03 Marks]

[e] A certain electronic component is produced in the Company XYZ. To increase the quality of the production, you are given the responsibility of automating the electronic component production. However, due to a sudden global material crisis, the cost of production varies as follows.

- Direct material : Rs. 20 per piece
- Direct labor : Rs. 12 per piece
- Fixed overhead : Rs. 28,000 for a production quantity of 2000 pieces
- Variable overhead : Rs. 15 per piece

The same component could be outsourced and the costs are as follows.

- Purchase piece : Rs. 42 per piece
- Cost of transportation : Rs. 3000 per 500 pieces

Decide whether to buy or produce this item. By automating the production, if the fixed overhead can be reduced by 15% and labour cost by 10%, would your decision be changed?

[05 Marks]

QUESTION 02 [20 MARKS]

[a] Explain the benefits of Industrial Automation (at least 5 benefits).

[05 Marks]

[b] Using Relative Strengths and Attributes of Humans and Machines, describe the necessity of industrial automation for a Cement Manufacturing plant.

[02 Marks]

[c] Discuss the "Human Roles in Automated Manufacturing Systems".

[02 Marks]

[d] An articulated robot loads and unloads parts in a CNC (computer numerical control) machine cell in a high production run (assume setup time can be neglected). The machine tool operates on semiautomatic cycle which is coordinated with the robot using interlocks. The programmed machining cycle takes 3.8 min. Cutting tools wear out and must be periodically changed, which takes 4.5 min every 15 cycles and is performed by a human worker.

At the end of each machining cycle, the robot reaches into the machine and removes the just-completed part, places it in a part container, then reaches for a starting work part from another container and places it in the machine tool chuck. This sequence of handling activities takes 20 sec. Part Container are exchanged every 20 work cycles by the same worker who changes tools, but there is no lost production time during this container exchange.

After machining 150 units, the machine must be stopped to cool down and refill the coolant tank and then restarted after a while. This average setup time is 15 minutes.

Determine,

[i] The Average production time

[ii] Production rate of the cell

Useful Equations

$$T_c = T_o + T_h + T_t \quad T_p = \frac{T_{su} + QT_c}{Q} \quad R_p = \frac{60}{T_p}$$

[05 Marks]

[e] A work cell is currently operated 8 hours per day, 7 days per week, and 24 days per month by a human worker who is paid an hourly rate of Rs. 300. Annual material+overhead cost is Rs. 460800. One work unit is produced in a cycle time of 3 minutes.

Management would like to increase output to meet increasing demand and a robot cell is being considered as a replacement for the present manual cell with same annual operational hours and same annual material+overhead cost. The cycle time of the proposed cell would be reduced to 2 minutes. The installation cost of the robot plus supporting equipment is Rs. 1,000,000. Power and other utilities to operate the robot will be Rs. 250/hr, and annual maintenance costs are Rs. 35,000. Determine,

[i] The number of units produced annually by the manually operated cell

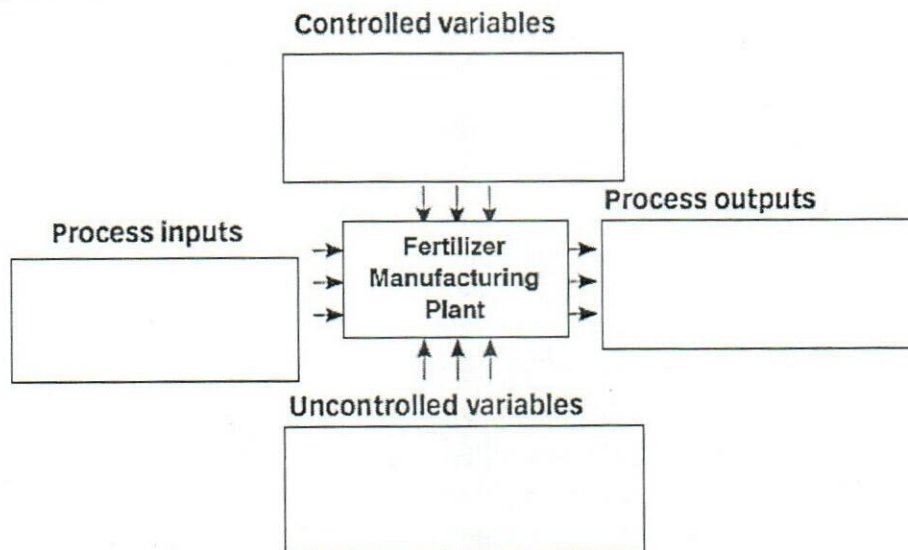
[ii] Cost per unit produced by the manually operated cell

[iii] Determine the cost per unit if the robot cell is implemented and compare with your answer in part [ii], given a 5-year service life and no salvage value. Based on your answer, would you recommend the robot cell to the Management?

[06 Marks]

QUESTION 03 [20 MARKS]

[a] Redraw the **Figure 3.1** in your answer script and complete it by identifying the Controlled variables, Uncontrolled variables, Process inputs, and Process outputs of a Fertilizer Manufacturing Plant.

**Figure 3.1****[08 Marks]**

[b] What is an Industrial Control System (ICS)? Elaborate your answer by describing the purpose, components, function, and security of an ICS.

[02 Marks]

[c] Describe the function and applications of Distributed Control System (DCS).

[02 Marks]

[d] What is an Industrial Internet of Things (IIoT)? How does it differ from IoT?

[02 Marks]

[e] Redraw and complete **Table 3.1** in your answer script.

Table 3.1

Comparison Factor	Continuous Control in Process Industries	Discrete Control in Discrete Manufacturing Industries
Typical measures of product output		
Typical quality measures		
Typical variables and parameters		

[06 Marks]

QUESTION 04 [20 MARKS]

[a] Figure 4.1 shows a Manually-operated Bottle Filling Station which is currently being used in a company, which requires 3 operators to function. Job descriptions of each operator are as follows:

- Operator 1 Fill up the Stock Tank up to the level “H” when it nears the level “L”, Add the empty plastic bottles to the conveyor, and remove the filled and capped bottles from the conveyor.
- Operator 2 operate the Manually operated conveyor and move the bottles to be placed under the nozzle of the valve to be filled. He also fixes the caps to the bottles which are filled by the Operator 3.
- Operator 3 carefully open and close the “Manually operated valve” and fill the bottles to a constant level by observing the level inside the transparent bottles.

You are assigned with automating this process, and you can select sensors and actuators as you see fit for automating different sub processes.

[i] Create a list of all possible sub processes which must be performed by the automated system you are going to design. (e.g., Sensing liquid level, sensing bottle position, motor-controlled conveyor etc.)

[ii] By using your Mechatronics knowledge, select the sensors, actuators, controllers and other components which can be used to automate each sub process.

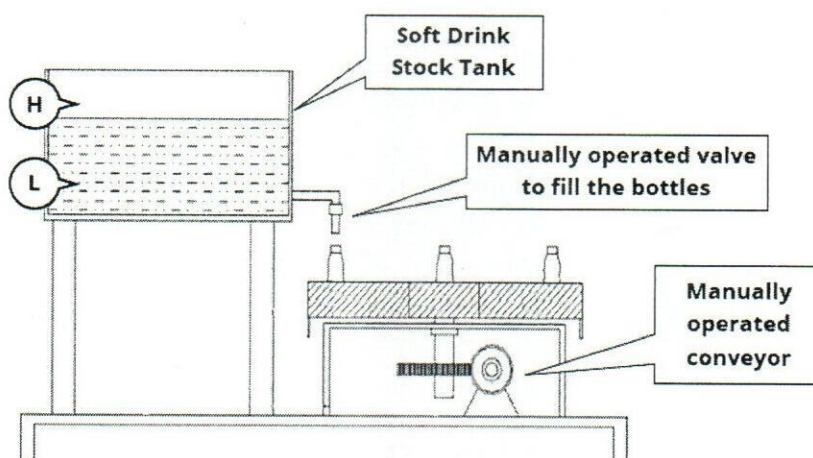


Figure 4.1

[08 Marks]

[b] Describe four (04) types of sensors used in Robotics systems in Industrial automation.

[02 Marks]

[c] Illustrate three (03) types of common robot configurations available for industrial robot constructions.

[06 Marks]

[d] Safety monitoring in an automated system involves the use of sensors to track the system's operation and identify conditions and events that are unsafe or potentially unsafe. State four (04) such sensors and their purposes/potential safety monitoring applications within an automated system.

[04 Marks]

QUESTION 05 [20 MARKS]

[a] Elaborate the statement “Endowing a manufacturing system with flexibility increases its complexity”.

[03 Marks]

[b] State four (04) factors that can affect the quality of a production system with suitable examples.

[02 Marks]

[c] Traditional Quality Control focuses on inspection. In many factories, the only department responsible for quality control was the inspection department. Much attention was given to sampling and statistical methods, which were termed statistical quality control.

[i] What is the purpose of Statistical Quality Control (SQC) in Manufacturing Systems?

[ii] What are the two main statistical sampling methods in production systems?

[iii] What is risk associated with statistical sampling?

[04 Marks]

[d] An automated guided vehicle system (AGVS) is a material handling system that uses independently operated, self-propelled vehicles guided along defined pathways. Consider the AGV system layout shown in **Figure 5.1**. Vehicles travel counter-clockwise around the loop to deliver loads from the load station to the unload station. Loading time at the load station is 1.25 min, and unloading time at the unload station is 0.75 min.

The following performance parameters are given for an AGV: vehicle speed = 65 m/min, availability = 0.85, and traffic factor = 0.88. Operator efficiency does not apply, so $E_w = 100\%$. Ignoring the effects of slightly shorter distances around the curves at corners of the loop, determine,

[i] Loaded Travel Distances and Empty Travel Distances

[ii] Ideal cycle time per delivery per vehicle

[iii] Number of vehicles required to satisfy the delivery demand if a total of 40 deliveries per hour must be completed by the AGVS.

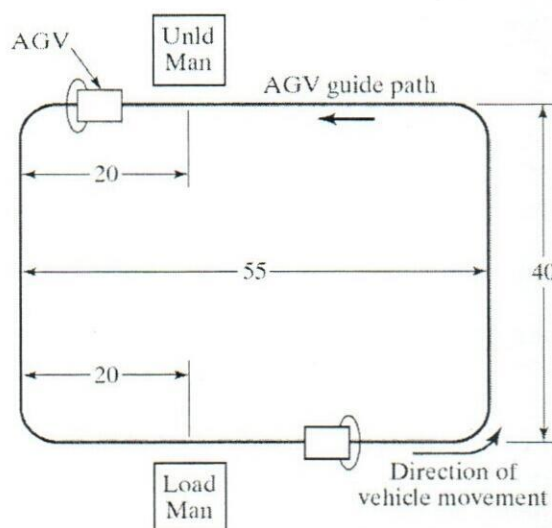


Figure 5.1

Hints:

Key: Unld = unload, Man = manual operation, dimensions in meters (m)

Useful Equations

$$T_c = T_L + \frac{L_d}{v_c} + T_U + \frac{L_e}{v_c}$$

$$AT = 60AF_tE_w$$

$$R_{dv} = \frac{AT}{T_c}$$

$$WL = R_f T_c$$

$$n_c = \frac{WL}{AT}$$

[06 Marks]

[e] **Figure 5.2** shows a block diagram of power generation section in a thermal power plant.

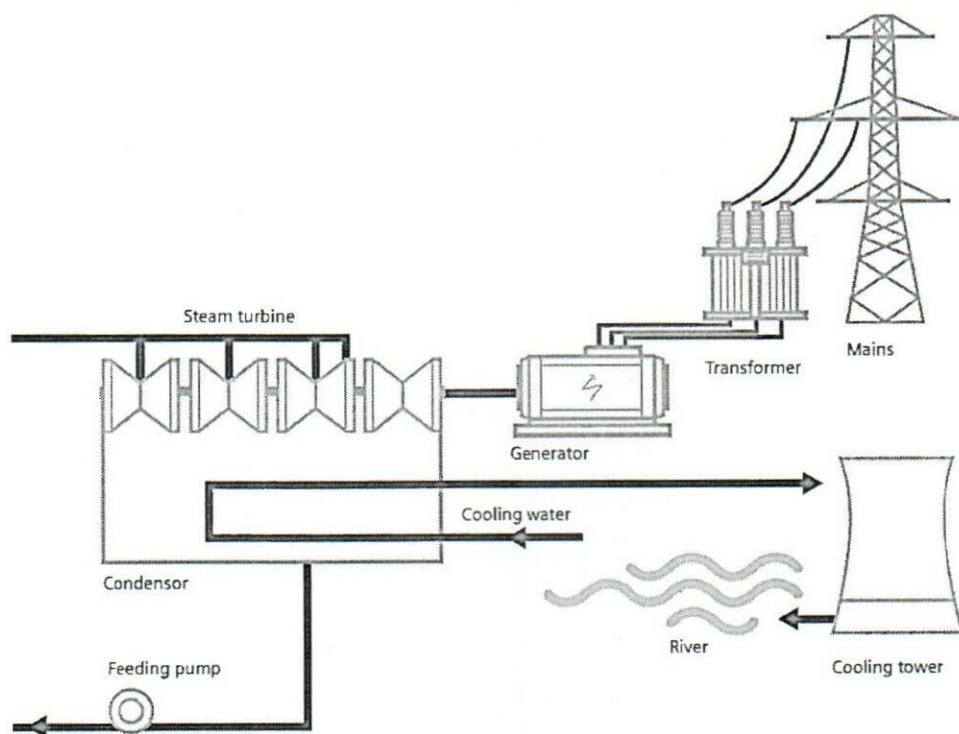


Figure 5.2

- [i] What are the sensors required to **remotely monitor** this section of the plant?
- [ii] Discuss how the Plant Maintenance and Life Cycle could be improved because of automation.
- [05 Marks]**

***** END OF QUESTION PAPER *****



Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
BSc Hons (Eng) Mechanical Engineering
BSc Hons (Eng) Automotive Engineering
Year 4 Semester 7 First-sit Final Examination 2026

Module Code	:	EE4315
Module Title	:	Industrial Instrumentation
Date/Time	:	20th April 2026 / 1300-1600
Examiners	:	Srimal Punchihewa
Time Allowed	:	1300-1600; 3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination. No reference materials are allowed.
- This paper consists of five (05) questions. Answer all questions.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question, consult the Supervisor or Invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.
- This examination paper contains seven (07) pages.

Q1. (a)

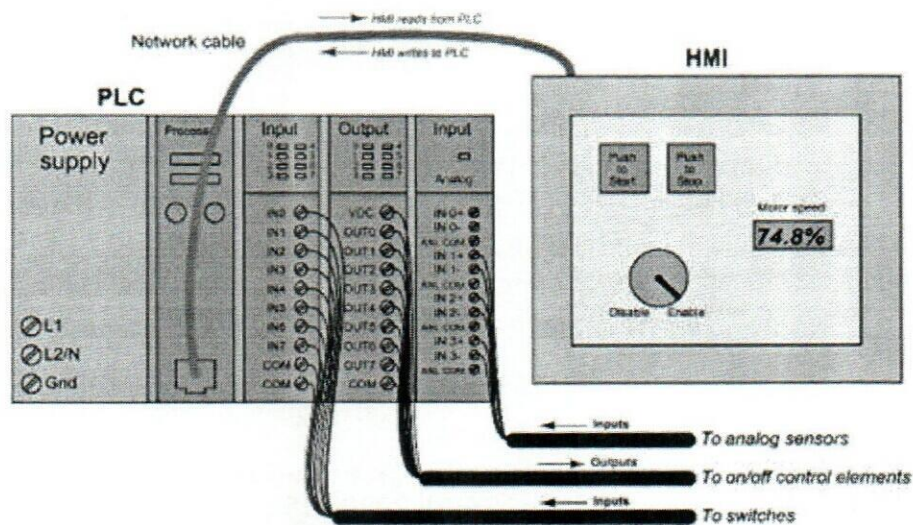


Fig 1.1

The Fig 1.1 Shows a human-machine interface (HMI) used with a PLC system.

Discuss briefly the primary function of an HMI which is used with a PLC system.
(6 marks)

(b)

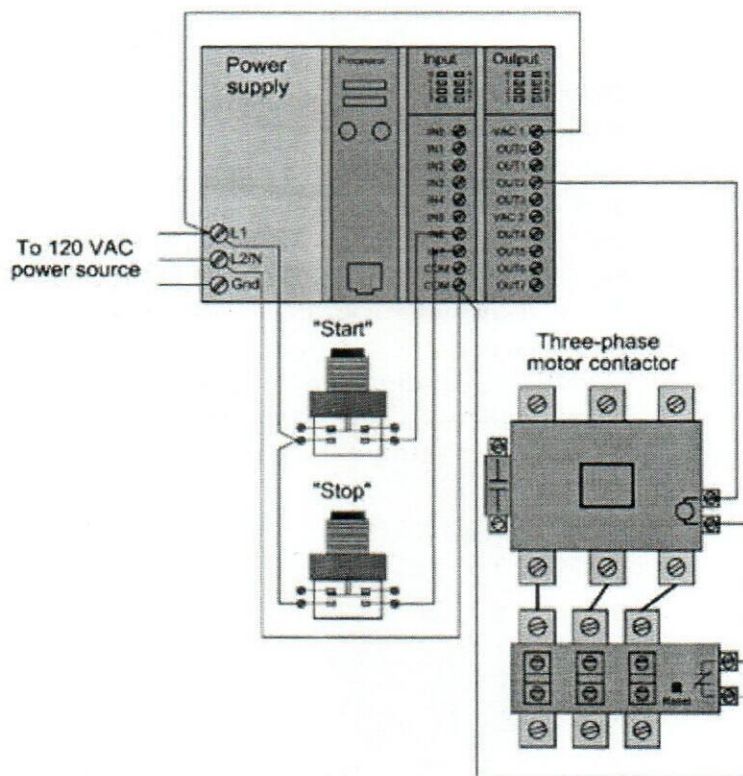


Fig 1.2

The Fig 1.2 shows a hypothetical circuit of a very common application of latching start/stop program for controlling electric motors, by means of momentary-contact push-button switches in industrial PLC systems.

Discuss briefly the functionality of this circuit by using a ladder logic diagram.

(12 marks)

(c)

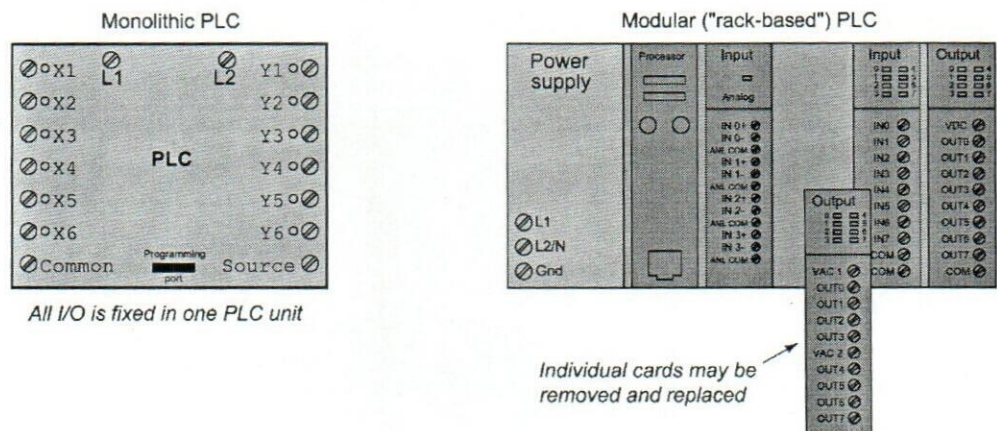


Fig 1.3

Fig 1.3 shows a Monolithic or brick type PLC and a modular or rack type PLC.

Compare and contrast the I/O capabilities of the two types of PLCs.

(7 marks)

(Total 25 marks)

Q2. (a)

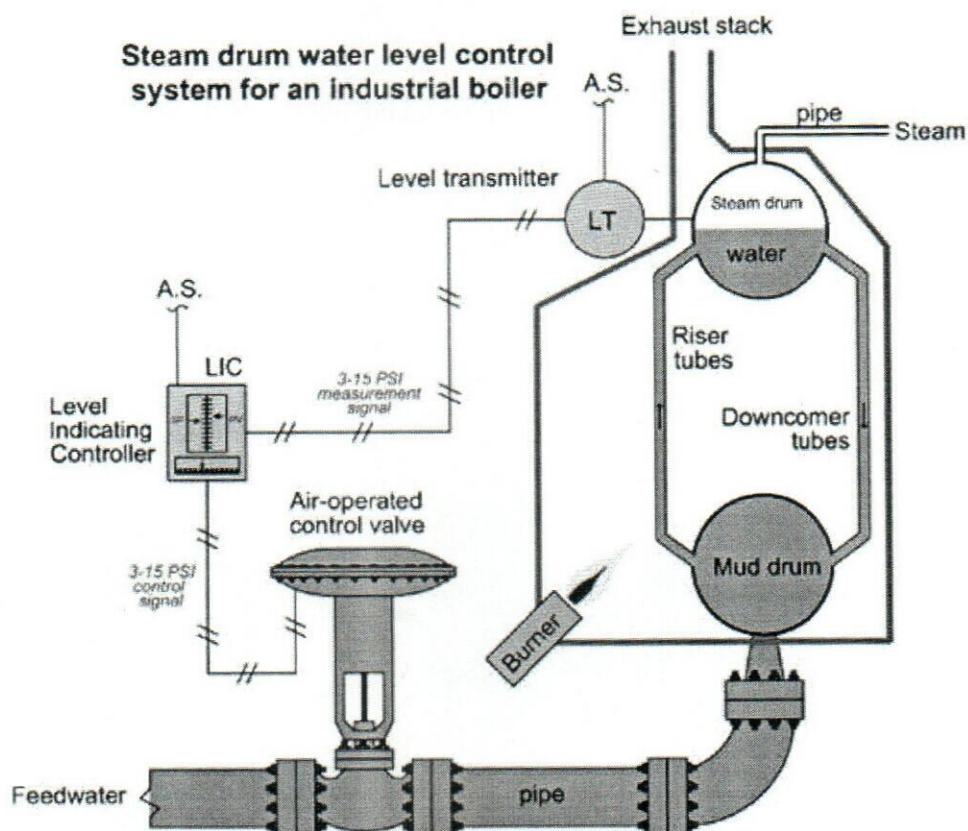


Fig 2.1

Fig 2.1 shows a "steam drum water level control system for an industrial boiler". This system integrates various sensors, instruments and interconnections to achieve an automatic control system.

Incorporating the above information about this system, briefly describe what is meant by Instrumentation.

(5 marks)

- (b) Monitoring is a core component of Industrial Instrumentation. Discuss briefly, how is monitoring performed, and why it is important.

(5 marks)
(Total 10 marks)

- Q3. (a) Considering the basic design techniques of industrial instruments, compare and contrast between the **basis** of traditional design approach and mechatronics design approach.
- (4 marks)
- (b) Discuss briefly the advantages of mechatronics design when compared to those of traditional design.
- (4 marks)
- (c) Draw a block diagram, indicating the design procedure involving an industrial system.
- (7 marks)
(Total 15 marks)

- Q4. (a) When a sensor is used in an industrial control system, it is calibrated. Briefly describe the benefits of sensor calibration.

(06 marks)

(b)

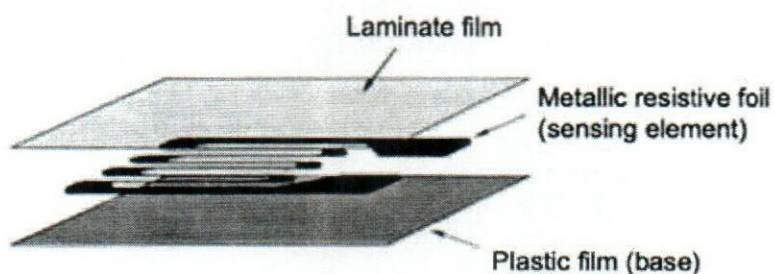


Fig 4.1

Fig 4.1 shows the internal construction of a strain Guage.

Explain the specific reasons why conductive metal film is arranged in a grid pattern.

(06 marks)

(c)

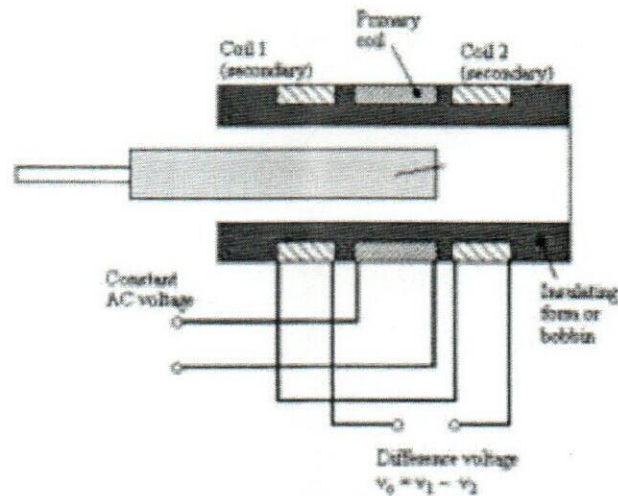


Fig 4.2

Fig 4.2 shows a case of LVDT where the steel iron core had moved to the left-hand side under the influence of an external force.

Derive the net output using a suitable circuit diagram.

(07 Marks)

(d)

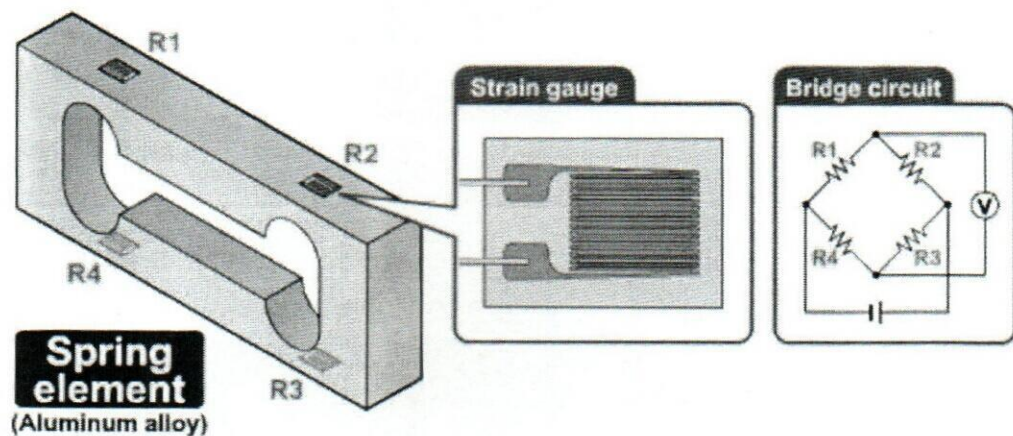


Fig 4.3

Fig 4.3 shows a Strain Gauge load cell.

Describe briefly the importance of proper bonding of the strain gauges to the load cell.

(06 Marks)

(Total 25 marks)

Q5. (a)

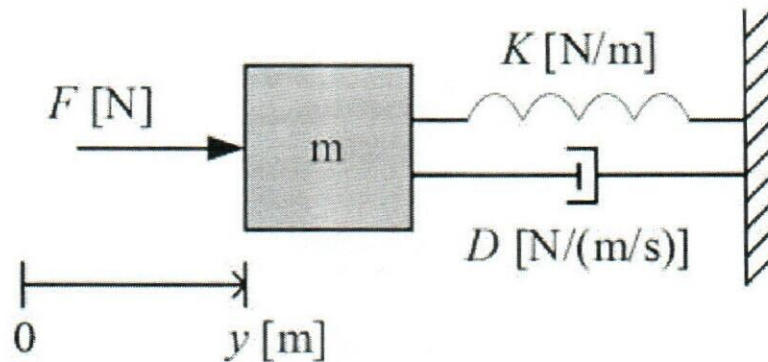


Fig 5.1

Fig 5.1 shows a mass-spring-damper system.

Using suitable block diagrams, show the system as a

(i) Differential equation, and

(ii) Difference equation.

(15 marks)

- (b) At the receiver end of a Data Acquisition, Conversion and Distribution system, analogue signal is reconstructed by using hold circuits.

Illustrate Zero-order and First-order hold methods using suitable diagrams.

(10 marks)

(Total 25 marks)

END OF THE QUESTION PAPER



Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Year 3 Semester 6 Resit Final Examination 2023

Module Code	:	EE3326
Module Title	:	Advanced Electronics
Date/Time	:	11 th February 2026 / 0900-1200
Examiners	:	Srimal Punchihewa
Time Allowed	:	0900-1200; 3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination. No reference materials are allowed.
- This paper consists of five (05) questions. Answer all questions.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
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- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.
- This examination paper contains six (06) pages.

- Q1. (a) Discuss briefly the reasons why with the Faraday Cage a perfect electric shield cannot be achieved. (6 marks)
- (b) Metal enclosures are used as equipment boxes. Sometimes holes are made in the box for ventilation etc.
- Discuss the factors which determine the amount of electromagnetic leakage through an aperture in a thin barrier (5 marks)
- (c) In a medium wave Transmitting station, the transmitter building is housed inside the near field. A twisted pair is to be used to connect the telephone instrument and the rosette.
- Draw a schematic and discuss how a twisted pair can be screened (5 marks)
- (d) Discuss briefly the shot noise. (4 marks)
- (Total 20 marks)

Q2. (a)

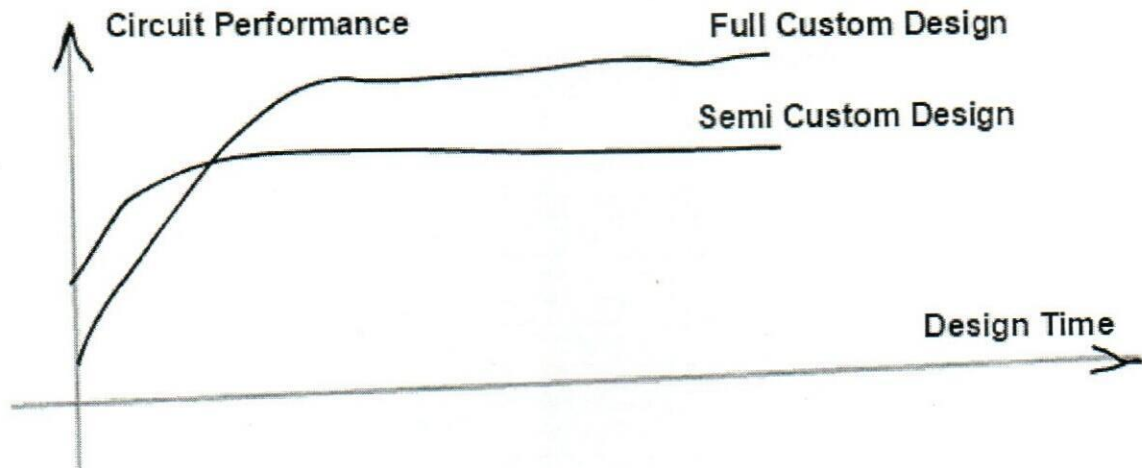


Fig 2.1

- I. Commencing with a diagram similar to Fig 2.1, compare Full Custom and semi-custom designs. Indicate "time for Maturity", "Opportunity for Performance Improvement" in your diagram.
- II. Discuss using a suitable table, how "the use of libraries", "dependency on existing technology", and "cost" differ between the two types of Design.

(6 marks)

The questions (b) to (h) are regarding CMOS fabrication.

- (b) Discuss the technologies that can be used for CMOS fabrication.
- (c) "Oxidation" process is done as one of the steps. Discuss briefly how this process is done.
- (d) A photoresist layer is formed on top of the device. Discuss briefly the function of photoresist.
- (e) Necessity arises to remove part of photoresist and sometimes the complete photoresist layer. Discuss briefly how it is done in each of the cases.
- (f) Discuss briefly how N-well is formed.
- (g) Necessity arises to remove part of oxide layer and sometimes the complete oxide layer. Discuss briefly how it is done in each of the cases.
- (h) Discuss the metal used for metallic contacts and the process used to deposit the same.

(2X7=14 marks)
(Total 20 marks)

- Q3. (a) A table indicating Lambda based rules used for VLSI design are given in Table 3.1

MINIMUM WIDTH AND SPACING RULES		
LAYER	TYPE OF RULE	VALUE
POLY	Minimum Width	2λ
	Minimum Spacing	2λ
N/P DIFFUSION	Minimum Width	3λ
	Minimum Spacing	3λ
N-WELL	Minimum Width	3λ
	Minimum Spacing	3λ
P-WELL	Minimum Width	3λ
	Minimum Spacing	3λ
METAL1	Minimum Width	3λ
	Minimum Spacing	3λ

Table 3.1

- Discuss briefly the significance of lambda.
 - Discuss briefly the importance of design rules for a process engineer. (6 marks)
- (b) Basic structure of the super junction MOSFET is shown in Fig 3.1.

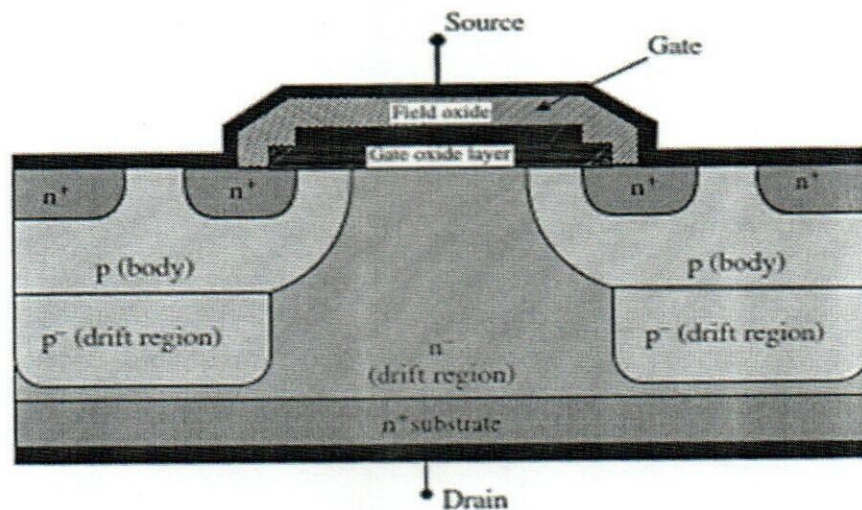


Fig 3.1

- Discuss the meaning of super junction.
- Discuss the basic thinking behind super junction MOSFET and its desired achievement.

(6 marks)

- (c) Cross sections of SiC Lateral Channel JFET (LCJFET) and Vertical trench JFET (VTJFET) are shown in Fig 3.2 and Fig 3.3

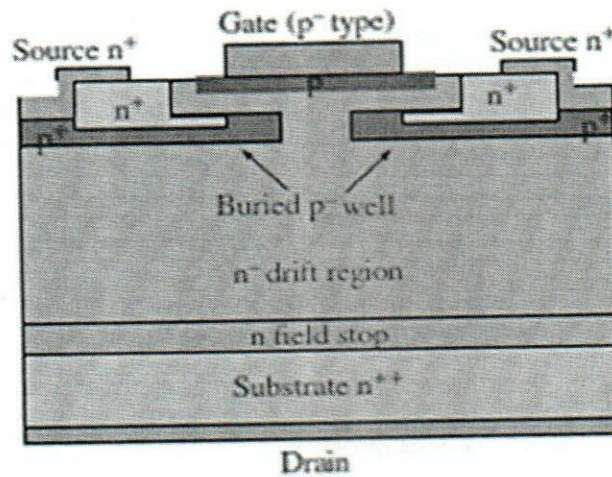


Fig 3.2

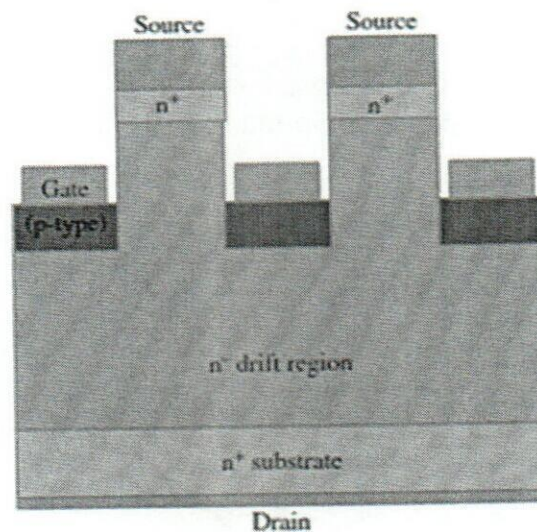
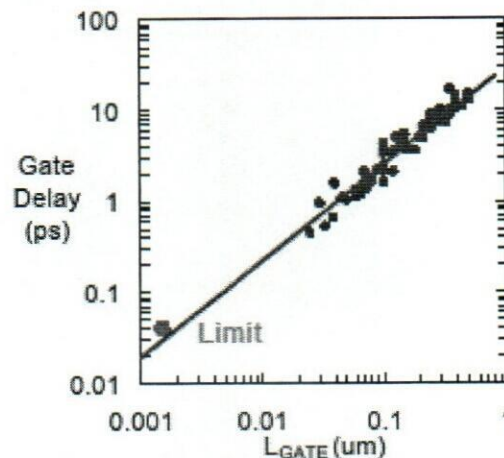


Fig 3.3

- I. Discuss the operation of SiC LCJFET.
- II. Discuss the operation of VTJFET.

(8 marks)
(Total 20 marks)

- Q4. (a) Discuss briefly the differences between GaN and SiC in Power Electronics (10 marks)
- (b) Discuss briefly the applications of wide band-gap semiconductor materials and write brief notes on them. (10 marks)
(Total 20 marks)
- Q5. (a) Discuss the categories of the groups that should be responsible about the global E-waste problem and briefly discuss them. (5 marks)
- (b) Discuss briefly absolute position and incremental position encoders (5 marks)
- (c) Briefly discuss the construction of self-aligned bulk SNWT using suitable diagrams (5 marks)
- (d) Discuss the statement "Speed increases as a result of scaling" referring Fig 5.1



Source: Mark Bohr, Intel

Fig 5.1

(5 marks)
(Total 20 marks)

END OF THE QUESTION PAPER



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
**BSc. Hons. (Eng.) in Automotive/ Electronic and Telecommunication/
Mechanical/ Mechatronic Engineering**
Semester 6 Re Sit - Final Examination 2026

Batch: 05

Module Code: EE3324	Module Title: Control Systems
Date: 13 February 2026	Duration: 03 Hours
Examiner 1: Mr. Randeera Liyanage	

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of four (4) questions and 7 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and log-linear sheets for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*

Q1

A conventional spring mass damper system is shown in Figure 1 (a). If an external force " $x(t)$ " is applied on the mass, it induces a force in the opposite direction from the spring and the damper consisting of a spring constant " k " and a damping coefficient of " b " respectively, resulting a change in displacement " $y(t)$ ".

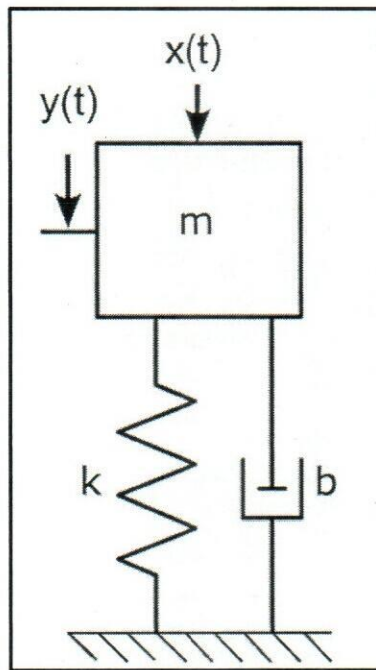
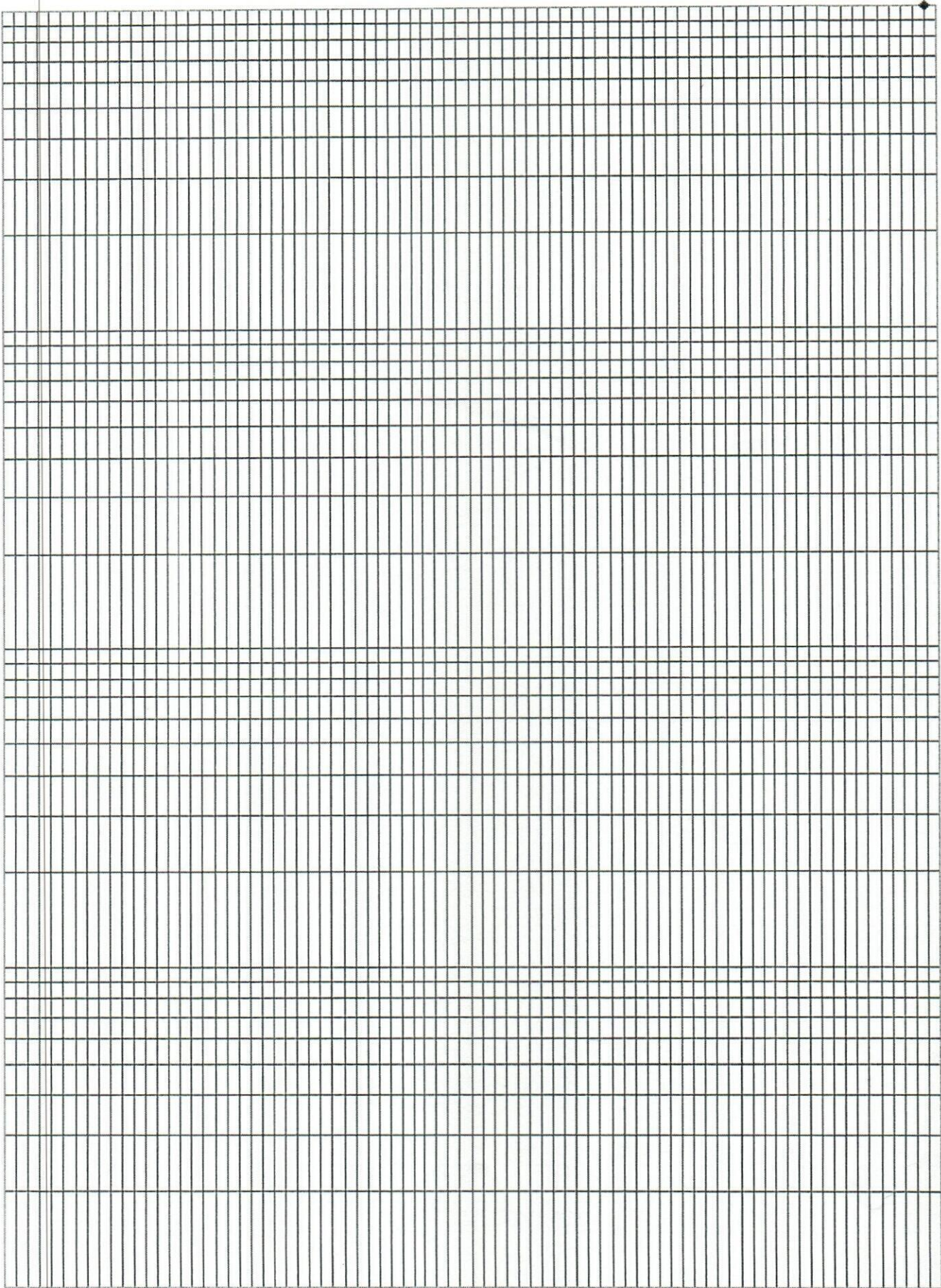
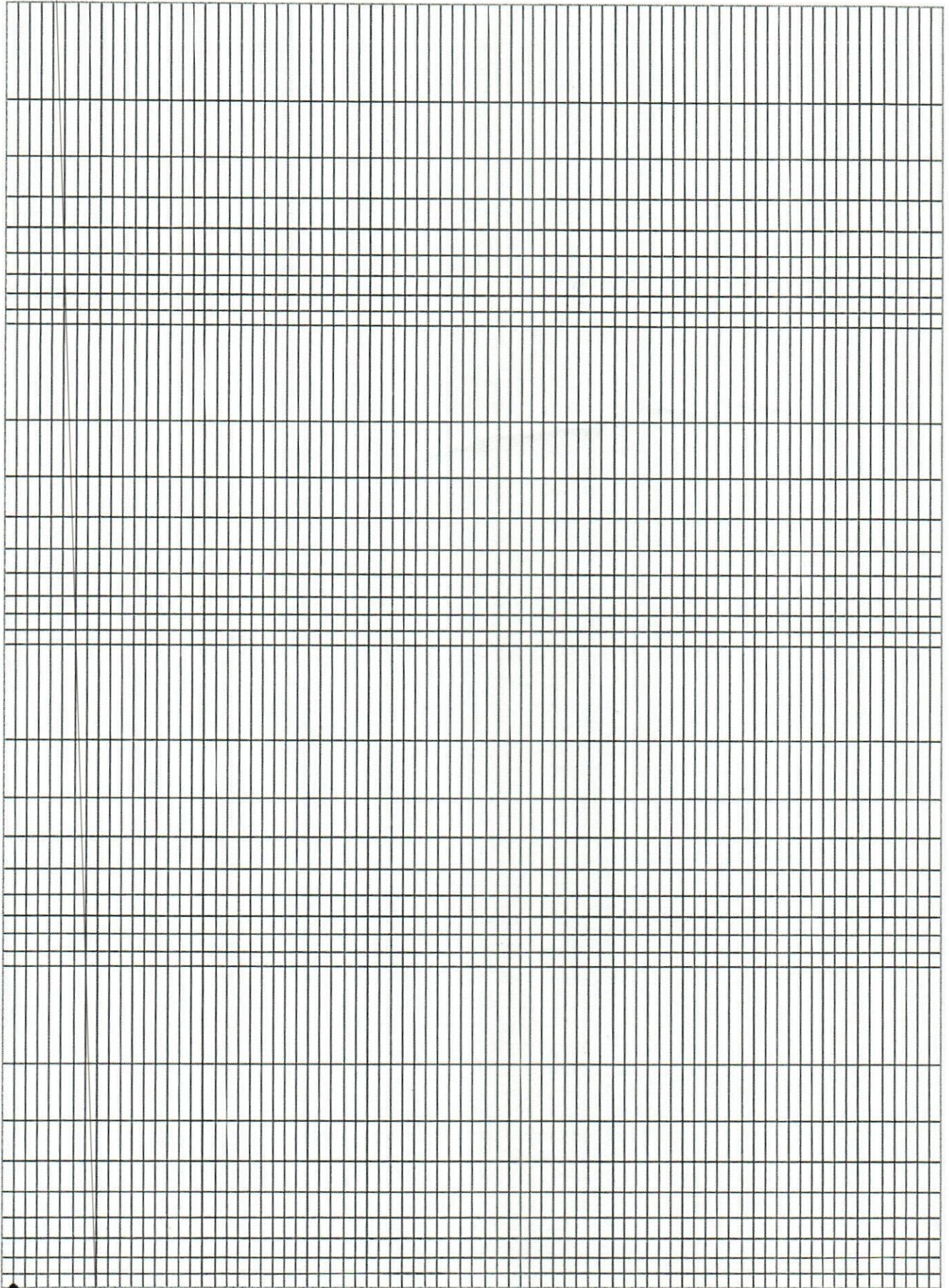


Figure 1 (a)

- Using the appropriate theories, obtain the differential equation for the above system. (06 Marks)
- Using the differential equation obtained in (a), derive the transfer function " $G(s)$ " between external force input " $x(t)$ " and displacement output " $y(t)$ ". (07 Marks)
- Determine the values of damping ratio " ζ ", natural frequency " ω_n " and steady state gain " K_{ss} " if $k = 1 \text{ Nm}^{-1}$, $b = 60 \text{ Nsm}^{-1}$ and $M = 10 \text{ kg}$. (07 Marks)
- Using the transfer function obtained in (b), and parameters mentioned in (c), draw the pole zero diagram and comment on the stability of the system. (05 Marks)

[Total – 25 Marks]





Q2

- a) Determine the stability of the system given in the following equation using the Routh-Hurwitz stability criterion. Hence, state the number of poles that are in the right-hand side, left-hand side and in the imaginary axis.

$$s^4 + s^3 + 2s^2 + 2s + 3$$

(04 Marks)

- b) Figure 2 (a) contains a rotational spring mass damper system along with its individual components.

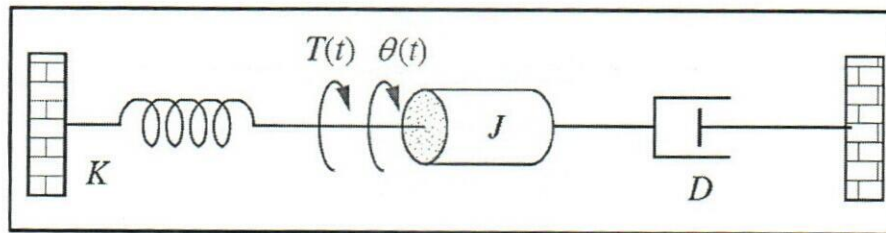


Figure 2 (a)

- Derive the transfer function for the given system. (Assume $K = 5 \text{ N/m}$, $J = 0.26 \text{ kg.m}^2$ and $D = 1.04 \text{ N.m.s/rad}$) (04 Marks)
- Using the transfer function obtained in (i), draw the pole zero diagram and comment on the stability of the system. (04 Marks)
- Calculate the damping ratio using the transfer function obtained in (i) and comment on the nature of oscillations in the system with reference to the damping ratio and the illustrated pole zero diagram in (ii). (04 Marks)
- Calculate the steady state error using the open loop transfer function of the system for a unit step input. (04 Marks)
- To improve the steady state error and overall response, a proportional gain is introduced to the original system "G(s)" as shown in Figure 2 (b). If the proportional gain K_p is 5, determine the steady state error for a unit step input. (05 Marks)

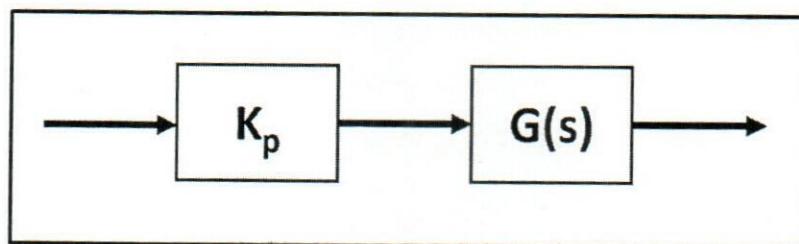


Figure 2 (b)

[Total – 25 Marks]

Q3

A unity feedback control system has the following open loop transfer function.

$$G(s) = \frac{1}{s(s+1)(s+2)}$$

- (a) Using the open loop transfer function above, obtain expressions for the frequency response (magnitude and phase). (02 Marks)
- (b) Plot the resulting Bode diagram (magnitude and phase) using the log-linear sheet provided in Annex I. (Note – You must attach the log-linear sheet to your answer script) (10 Marks)
- X Axis Range: 0.1 rad/s – 10 rad/s
- (c) Measure and calculate the resultant Gain Margin (GM) and Phase Margin (PM). (Show your measurements clearly in the Bode diagram). (05 Marks)
- (d) The design requirement for the above system states that there should be a Phase Margin (PM) of 70° . To meet the new Phase Margin (PM) requirement, the design engineers have decided to introduce a gain compensator as shown in Figure 3 (a). (08 Marks)
- Determine the value of gain "K" required to provide a Phase Margin, $PM = 70^\circ$

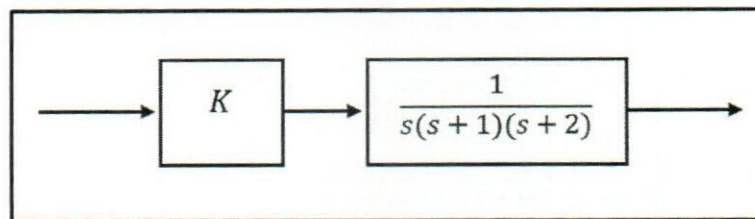


Figure 3 (a)

[Total – 25 Marks]

Q4

- a) Describe two advantages of digital control compared to its analogue counterpart. (*Use 2 sentences for the explanation.*) (02 Marks)
- b) Describe one technique used to convert a digital control signal to an analogue actuator signal. (*Use 2 sentences for the description.*) (02 Marks)
- c) An analogue controller is designed with the transfer function given below. The design engineers have decided to implement a digital version of the controller by initially using a sample increment of $T = \frac{1}{4}s$.

$$G(s) = \frac{1}{0.5s + 1}$$

- i. Plot the unit step response of the analogue controller $G(s)$ for a period of $0s \leq t \leq 3s$. (08 Marks)
- ii. Obtain the equivalent Z-transfer function using Tustin transformation. (03 Marks)
- iii. Using the Z-transfer function obtained in *part i*, determine the difference equation and plot the unit step response of the digital controller for a period of $0s \leq t \leq 3s$. (08 Marks)
- iv. Describe the compatibility with the digital controller's response. (*Use 2 sentences for the description.*) (02 Marks)

[Total – 25 Marks]

CONTROL DATA SHEETS**Design via Frequency Domain****Gain Adjustment**

$$\zeta = \frac{-\ln(\%OS/100)}{\sqrt{\pi^2 + \ln^2(\%OS/100)}} ; \quad \Phi_M = \tan^{-1} \frac{2\zeta}{\sqrt{-2\zeta^2 + \sqrt{1+4\zeta^4}}}$$

Second Order System Standard Form

$$G(s) = \frac{K_{ss}\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

Standard Performance of a Second Order System

$$\text{Time to first peak; } T_p = \frac{\pi}{\omega_n \sqrt{1-\zeta^2}} ; \quad \text{Settling time; } T_s = \frac{4}{\zeta\omega_n} ; \quad \text{Rise time; } T_r = \frac{1.8}{\omega_n}$$

$$\text{Percentage Overshoot; } \%OS = e^{-(\zeta\pi/\sqrt{1-\zeta^2})} \times 100 ; \quad \zeta \cong 0.01 \times PM$$

$$\left(\frac{\omega_c}{\omega_n}\right)^2 \cong \sqrt{4\zeta^4 + 1} - \zeta^2$$

Where ζ is the damping ratio, ω_n is the natural frequency, ω_c is the crossover frequency and PM is the Phase Margin.

Bode Plot

$$GM = 0 - x ; \quad PM = \phi + 180$$

$$-x \text{ dB} = 20 \log(K)$$

Modelling Equations

$$\text{Spring; } F = kx(t) ; \quad \text{Damper; } F = b\dot{x}(t)$$

$$\text{Capacitor Current; } I = C \frac{dV_c}{dt} ; \quad \text{Inductor Voltage; } V = L \frac{dI_L}{dt}$$

Steady State Error

$$E(s) = R(s) - X(s) ; \quad E(s) = \frac{R(s)}{1 + G(s)} ; \quad E_{ss} = \lim_{s \rightarrow 0} s \cdot E(s)$$

Where "G(s)" is the open loop transfer function, and "R(s)" is the system input.

Tustin Transform

$$s = \frac{2}{T} \left(\frac{Z-1}{Z+1} \right)$$

TABLE OF LAPLACE AND Z TRANSFORMS

$f(t)$	$F(s)$	$f(k)$	$F(z)$
unit impulse: $\delta(t)$	1	$\delta(k)$	1
delayed unit impulse: $\delta(t - NT)$	e^{-NTs}	$\delta(k - N)$	z^{-N}
unit step: 1	$\frac{1}{s}$	1	$\frac{z}{z-1}$
unit ramp: t	$\frac{1}{s^2}$	kT	$\frac{Tz}{(z-1)^2}$
e^{-at}	$\frac{1}{s+a}$	e^{-akT}	$\frac{z}{z-e^{-aT}}$
-	-	α^k	$\frac{z}{z-\alpha}$
$\frac{1}{\tau} \cdot e^{-t/\tau}$	$\frac{1}{1+\tau s}$	$\frac{1}{\tau} \cdot e^{-kT/\tau}$	$\frac{1}{\tau} \cdot \frac{z}{z-e^{-T/\tau}}$
$1-e^{-t/\tau}$	$\frac{1}{s(1+\tau s)}$	$1-e^{-kT/\tau}$	$\frac{(1-e^{-T/\tau})z}{(z-1)(z-e^{-T/\tau})}$
$1-e^{-at}$	$\frac{a}{s(s+a)}$	$1-e^{-akT}$	$\frac{(1-e^{-aT})z}{(z-1)(z-e^{-aT})}$
-	-	$1-\alpha^k$	$\frac{z(1-\alpha)}{(z-1)(z-\alpha)}$
$\sin(\omega t)$	$\frac{\omega}{s^2+\omega^2}$		$\frac{z \sin \omega T}{z^2 - 2z \cos \omega T + 1}$
$\cos(\omega t)$	$\frac{s}{s^2+\omega^2}$		$\frac{z(z - \cos \omega T)}{z^2 - 2z \cos \omega T + 1}$
$e^{-at} \sin \omega t$	$\frac{\omega}{(s+a)^2 + \omega^2}$		$\frac{z e^{-aT} \sin \omega T}{z^2 - 2z e^{-aT} \cos \omega T + e^{-aT}}$
$e^{-at} \cos \omega t$	$\frac{(s+a)}{(s+a)^2 + \omega^2}$		$\frac{z^2 - z e^{-aT} \sin \omega T}{z^2 - 2z e^{-aT} \cos \omega T + e^{-aT}}$

-END OF EXAMINATION PAPER-



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Batch 5 Semester 6 Resit Final Examination 2025

Module Code	:	EE3327
Module Title	:	Electronic Instrumentation
Date	:	07 th February 2026
Examiners	:	Srimal Punchihewa
Time Allowed	:	1330-1630; 3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination. No reference materials are allowed.
- This paper consists of six (06) questions. Answer all questions.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.
- This examination paper contains eight (08) pages.

Q1

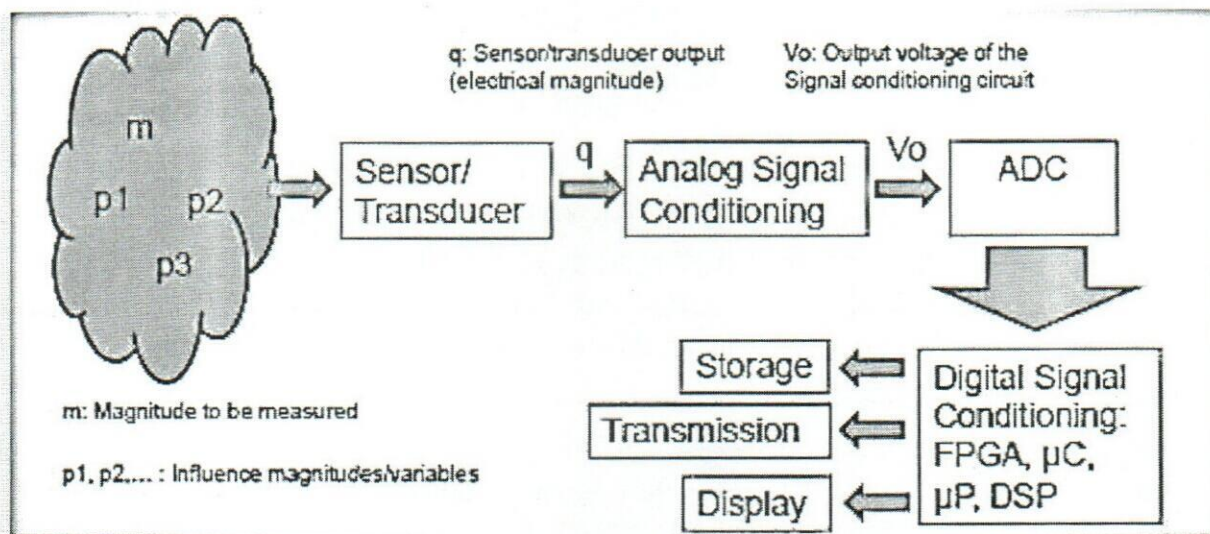


Figure 1.1

(a)

Figure 1.1 shows “Basic Architecture for an Electronic Instrumentation Measurement System”

Sensor/Transducer output may be too small, noisy, may have unwanted high frequencies and not suitable for the next stage Analog to Digital Converter.

Based on the above information, briefly explain what is being done during analog signal conditioning.

(3 marks)

(b)

Briefly explain the meaning of resolution as applicable to a sensor.

(3 marks)

(c)

What is meant by the “Dead Band” of a sensor?

(2 marks)

(d)

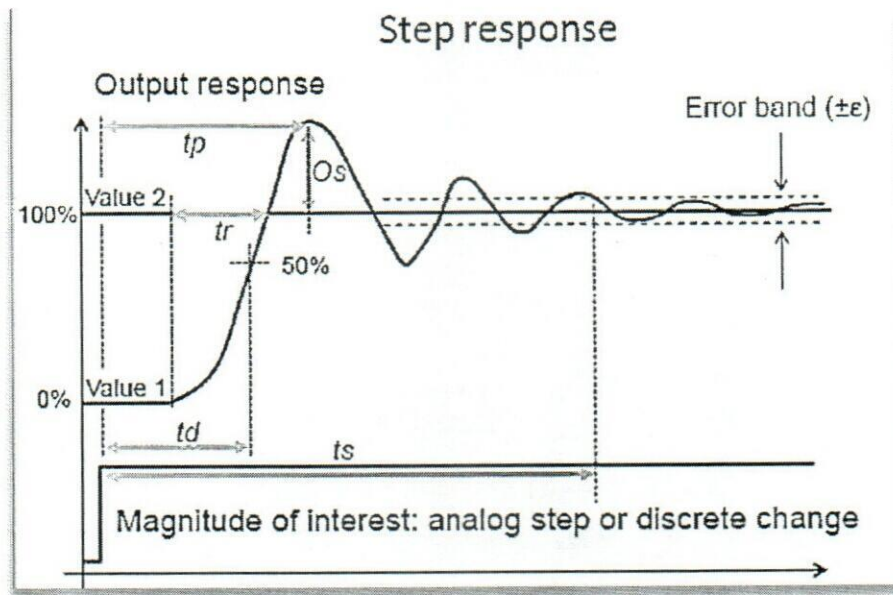


Figure 1.2

Figure 1.2 shows the response of a sensor to an analog step or discrete change. Define the parameters represented by " t_s " and " t_d "

(3 marks)

(e)

State different sources which cause random errors.

State the causes of Gross/Human errors

(3 marks)

(Total 14 marks)

Q2.

(a)

State the meaning of an error in a measurement

Briefly explain "Deflection Methods" and "Comparison Methods" in a measurement.

(5 marks)

(b) Differentiate between the two terms "Measurement" and "Measurand" as applicable to electronic measurement and instrumentation.

(2 marks)

(Total 7 marks)

Q3.

(a)

State two reasons for using "Data fusion techniques"

(3 marks)

(b)

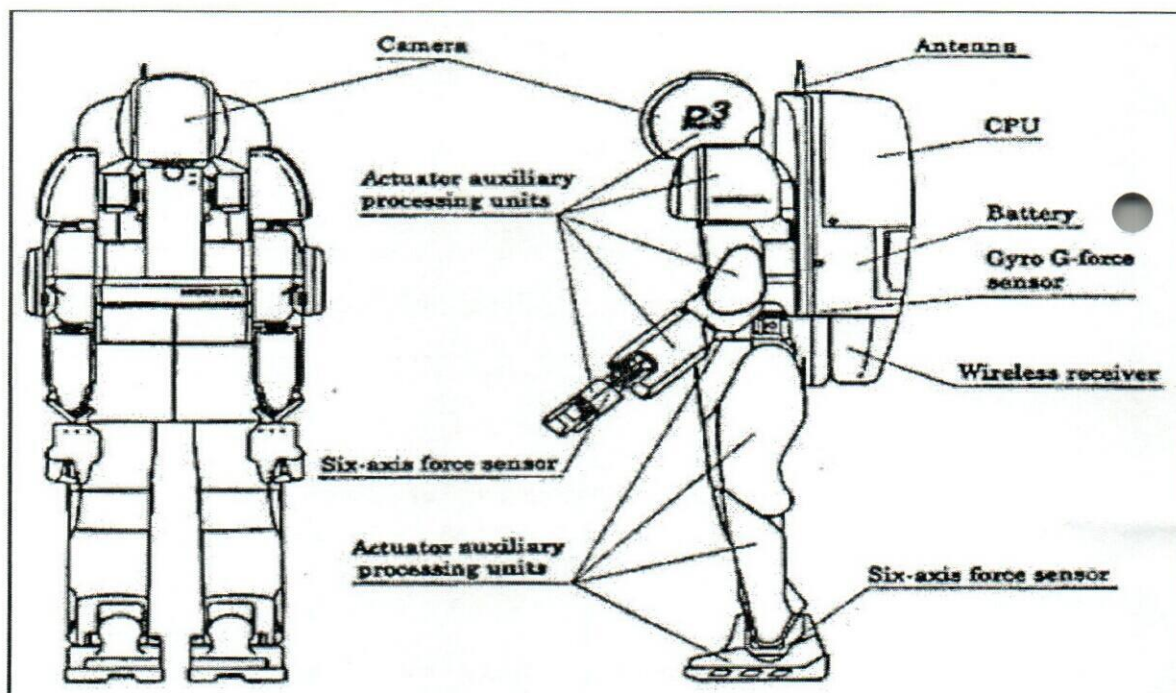


Figure 3.1

Figure 3.1 shows "Honda Humonoid Robot".

Describe briefly how the "Honda Humonoid Robot" uses multisensory fusion and integration.

(3 marks)

(c)

Discuss briefly the "offset", "nonlinearity" and "dynamic error" as applicable to a non-ideal sensor.

(3 marks)

(d)

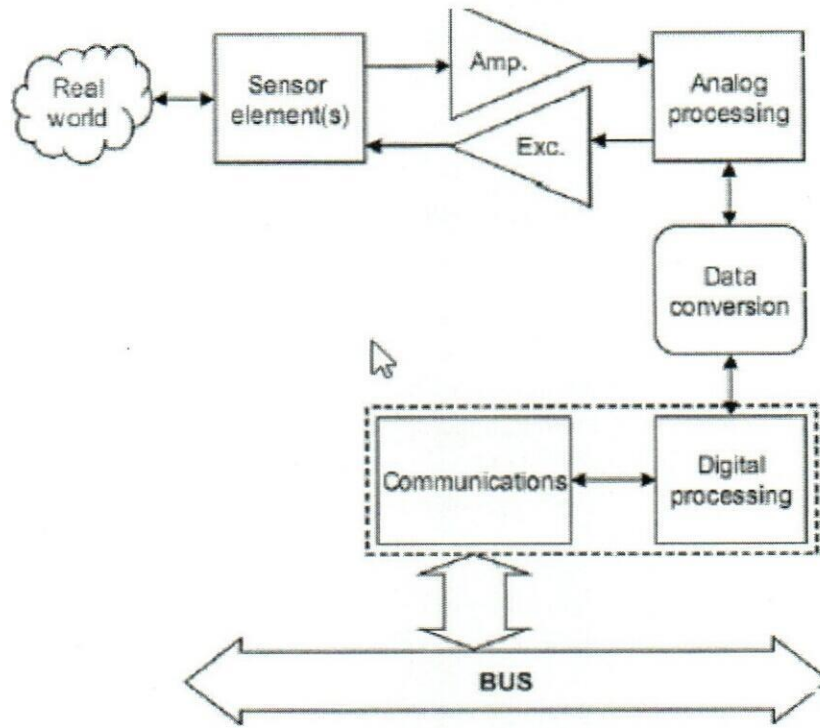


Figure 3.2

Figure 3.2 shows architecture of an intelligent sensor.

State how "Data Conversion" is achieved.

State the function of the block "Analog Processing"

State the reason for amplifying the output of the "Sensor element(s)"

(3 marks)

(e)

An intelligent sensor can do "Self-Calibration and Diagnostics", "Compensation", "Computation", and "Integration".

Write short notes on one of them.

(3 marks)

(f)

State three reasons why conventional sensors are not perfect when compared with intelligent sensors.

(3 marks)

(Total 18 marks)

Q4.

(a)

What is a light sensor?
Give three examples for a light sensor.

(3 marks)

(b)

State the rules obeyed by a good sensor.

(3 marks)

(c)

RTD is an electrical temperature sensor, and the abbreviation stands for
"Resistance Temperature Detector".

State the meaning of RTD specification indicated as 100Ω .

(3 marks)

(d)

If a 0-10V analog signal is to be converted to a 3 bit digital signal, calculate the
number of quantization levels required.

What binary codes could be used for each of these quantization level?

(5 marks)

(e)

Briefly describe two ways to enhance the accuracy in analog to digital
conversion.

(4 marks)

(Total 18 marks)

Q5.

(a)

The cutoff frequency of a low-pass filter is the frequency at which the filter's
output voltage is -3dB of the input voltage.

State the meaning of -3dB

(3 marks)

(b)

Draw the sketch of an active Bandpass filter circuit.

(4 marks)

(Total 7 marks)

Q6.

(a)

Sketch a successive approximation register type of Analog to Digital converter.

(3 marks)

(b)

If $V_{o(FS)} = 10.240\text{ V}$ and $V_A = 7.500\text{ V}$, the output of the DAC in a successive approximation register type of Analog to Digital converter is shown in Figure 6.1

Clock cycle	Register FF states $b_1(\text{MSB}) \cdots b_N(\text{LSB})$	DAC output voltage ($+\frac{1}{2}$ -LSB offset) (V)
1	1030000000	5.125
2	1100000000	7.685 (b_2 FF now reset to $b_2 = 0$)
3	1010000000	6.405
4	1011000000	7.045
5	1011100000	7.365
6	1011110000	7.525 (b_6 FF now reset to $b_6 = 0$)
7	1011101000	7.445
8	1011101100	7.485
9	1011101110	7.525 (b_9 FF now reset to $b_9 = 0$)
10	1011101101	7.495

Figure 6.1

Ratify the DAC outputs for Clock Cycles 1, 2, 3, 4 and 5 in Figure 5.1
Assume $\frac{1}{2}$ LSB offset.

(09 marks)

(b)

Describe briefly three advantages of Miniaturization.

(4 marks)

(c)

Describe briefly three applications of NEMS

(4 marks)

- (d) Describe briefly three applications of MEMS. (4 marks)
- (e) Sketch a Data Acquisition System Block Diagram (4 marks)
- (f) Describe briefly four Data Acquisition Hardware. (4 marks)
- (g) Describe briefly four Data Acquisition Software (4 marks)
- (Total 36 marks)

END OF EXAMINATION PAPER



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Year 2 Semester 3 Resit Final Examination 2025

Module Code : EE2316
Module Title : Signals and Systems
Date/Time : 16th September 2025
Examiners : Srimal Punchihewa
Time Allowed : 3 Hours; 0900-1200

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination. No reference materials are allowed.
- This paper consists of six (6) questions. Answer all questions.
- Use only the provided answer booklet, and additional sheets for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- **Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.**
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.
- This examination paper contains nine (9) pages.

Q1.

- (A) A continuous time signal $x(t)$ is shown in Fig 1.1. Sketch and label each of the following signals

- (a) $x(t/2)$
(b) $x(2t)$

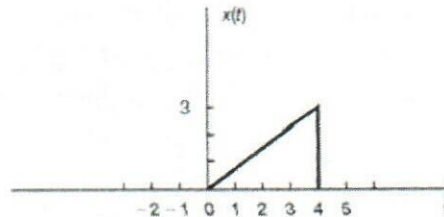


Fig 1.1

(3 Marks)

- (B) A discrete time signal $x[n]$ is shown in Fig 1.2. Sketch and label each of the following signals.

- (a) $x[2n]$
(b) $x[-n + 2]$

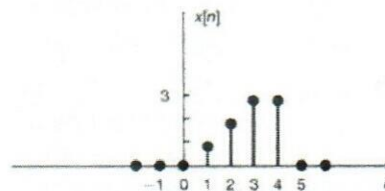


Fig 1.2

(3 Marks)

- (C) Find the even and odd components of $x(t) = e^{jt}$

(4 Marks)

- (D) A system has the input-output relation given by $y = \mathbf{T}\{\mathbf{x}\} = \mathbf{x}^2$

Show that this system is nonlinear.

(6 marks)

(Total 16 Marks)

Q2.

(A) Determine the complex exponential Fourier series representation for each of the following signals:

(a) $x(t) = \cos\left(2t + \frac{\pi}{4}\right)$

(b) $x(t) = \cos 4t + \sin 6t$

(10 Marks)

(B) Consider the periodic square wave $x(t)$ shown in Fig 2.1

Determine the complex exponential Fourier series of $x(t)$

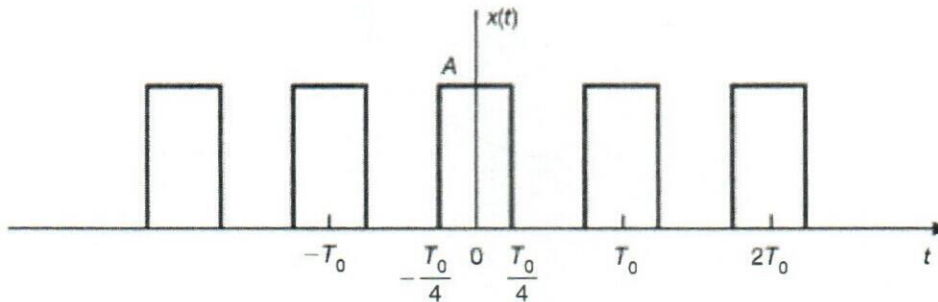


Fig 2.1

(10 Marks)
(Total Marks 20)

Q3.

(A) Find the Fourier Transform of the signal $x(t) = \cos \omega_0 (t)$

(6 Marks)

(B) Find the Fourier Transform of the signal shown in Fig 3.1 and defined by

$$x(t) = e^{-a|t|}$$

$$a > 0$$

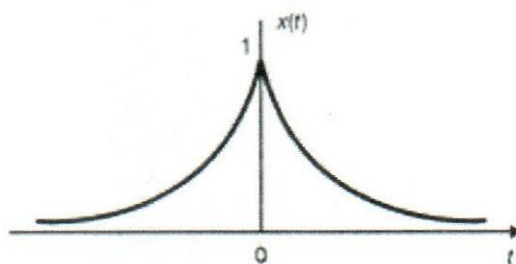


Fig 3.1

(6 Marks)

(Total Marks 12)

Q4.

(A) Consider a sequence

$$x[n] = \sum_{k=-\infty}^{\infty} \delta[n - 4k]$$

(a) Sketch $x[n]$ (b) Find the Fourier coefficients c_k of $x[n]$

(5 Marks)

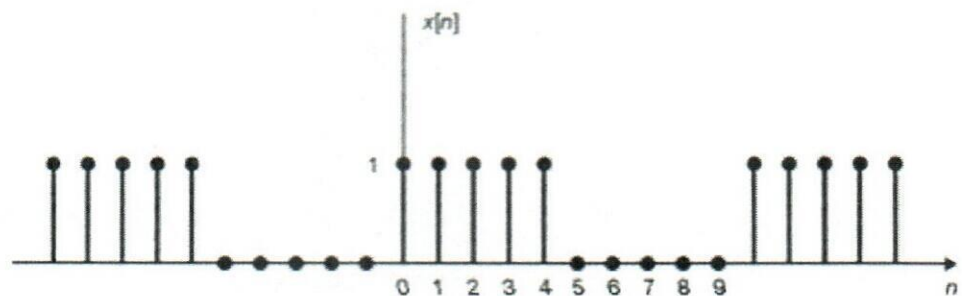
(B) Consider the periodic sequence $x[n]$ shown in Fig 4.1. Determine the Fourier coefficients c_k and sketch the magnitude spectrum $|c_k|$ 

Fig 4.1

(7 Marks)

(Total Marks 12)

Q5.

- (A) Find the Laplace transform $X(s)$ and sketch the pole-zero plot with the ROC for the following signals $x(t)$:

$$x(t) = e^{-3t}u(t) + e^{2t}u(-t)$$

(10 Marks)

- (B) Find the inverse Laplace transform of

$$X(s) = \frac{5s + 13}{s(s^2 + 4s + 13)} \quad \text{Re}(s) > 0$$

(10 Marks)

(Total Marks 20)

Q6.

- (A) Find the z-transform $X(z)$ and sketch the pole-zero plot with the ROC for the following sequence:

$$x[n] = \left(\frac{1}{3}\right)^n u[n] + \left(\frac{1}{2}\right)^n u[-n-1]$$

(10 Marks)

- (B) Using the partial fraction expansion, find the inverse z-transform of the following $X(z)$:

$$X(z) = \frac{z}{2z^2 - 3z + 1} \quad |z| < \frac{1}{2}$$

(10 Marks)

(Total Marks 20)

FORMULA SHEET

$$x(t) = \sum_{k=-\infty}^{\infty} c_k e^{jk\omega_0 t} \quad \omega_0 = \frac{2\pi}{T_0}$$

$$c_k = \frac{1}{T_0} \int_{T_0} x(t) e^{-jk\omega_0 t} dt$$

$$X(\omega) = \mathcal{F}\{x(t)\} = \int_{-\infty}^{\infty} x(t) e^{-j\omega t} dt$$

$$x(t) = \mathcal{F}^{-1}\{X(\omega)\} = \frac{1}{2\pi} \int_{-\infty}^{\infty} X(\omega) e^{j\omega t} d\omega$$

$$X(s) = \int_{-\infty}^{\infty} x(t) e^{-st} dt$$

$$X(z) = \sum_{n=-\infty}^{\infty} x[n] z^{-n}$$

$x(t)$	$X(s)$	ROC
$\delta(t)$	1	All s
$u(t)$	$\frac{1}{s}$	$\text{Re}(s) > 0$
$-u(-t)$	$\frac{1}{s}$	$\text{Re}(s) < 0$
$tu(t)$	$\frac{1}{s^2}$	$\text{Re}(s) > 0$
$t^k u(t)$	$\frac{k!}{s^{k+1}}$	$\text{Re}(s) > 0$
$e^{-at} u(t)$	$\frac{1}{s+a}$	$\text{Re}(s) > -\text{Re}(a)$
$-e^{-at} u(-t)$	$\frac{1}{s+a}$	$\text{Re}(s) < -\text{Re}(a)$
$te^{-at} u(t)$	$\frac{1}{(s+a)^2}$	$\text{Re}(s) > -\text{Re}(a)$
$-te^{-at} u(-t)$	$\frac{1}{(s+a)^2}$	$\text{Re}(s) < -\text{Re}(a)$
$\cos \omega_0 t u(t)$	$\frac{s}{s^2 + \omega_0^2}$	$\text{Re}(s) > 0$
$\sin \omega_0 t u(t)$	$\frac{\omega_0}{s^2 + \omega_0^2}$	$\text{Re}(s) > 0$
$e^{-at} \cos \omega_0 t u(t)$	$\frac{s+a}{(s+a)^2 + \omega_0^2}$	$\text{Re}(s) > -\text{Re}(a)$
$e^{-at} \sin \omega_0 t u(t)$	$\frac{\omega_0}{(s+a)^2 + \omega_0^2}$	$\text{Re}(s) > -\text{Re}(a)$

$x[n]$	$X(z)$	ROC
$\delta[n]$	1	All z
$u[n]$	$\frac{1}{1-z^{-1}}, \frac{z}{z-1}$	$ z > 1$
$-u[-n-1]$	$\frac{1}{1-z^{-1}}, \frac{z}{z-1}$	$ z < 1$
$\delta[n-m]$	z^{-m}	All z except 0 if $(m > 0)$ or ∞ if $(m < 0)$
$a^n u[n]$	$\frac{1}{1-az^{-1}}, \frac{z}{z-a}$	$ z > a $
$-a^n u[-n-1]$	$\frac{1}{1-az^{-1}}, \frac{z}{z-a}$	$ z < a $
$na^n u[n]$	$\frac{az^{-1}}{(1-az^{-1})^2}, \frac{az}{(z-a)^2}$	$ z > a $
$-na^n u[-n-1]$	$\frac{az^{-1}}{(1-az^{-1})^2}, \frac{az}{(z-a)^2}$	$ z < a $
$(n+1)a^n u[n]$	$\frac{1}{(1-az^{-1})^2}, \left[\frac{z}{z-a}\right]^2$	$ z > a $
$(\cos \Omega_0 n)u[n]$	$\frac{z^2 - (\cos \Omega_0)z}{z^2 - (2\cos \Omega_0)z + 1}$	$ z > 1$
$(\sin \Omega_0 n)u[n]$	$\frac{(\sin \Omega_0)z}{z^2 - (2\cos \Omega_0)z + 1}$	$ z > 1$
$(r^n \cos \Omega_0 n)u[n]$	$\frac{z^2 - (r \cos \Omega_0)z}{z^2 - (2r \cos \Omega_0)z + r^2}$	$ z > r$
$(r^n \sin \Omega_0 n)u[n]$	$\frac{(r \sin \Omega_0)z}{z^2 - (2r \cos \Omega_0)z + r^2}$	$ z > r$
$\begin{cases} a^n & 0 \leq n \leq N-1 \\ 0 & \text{otherwise} \end{cases}$	$\frac{1-a^N z^{-N}}{1-az^{-1}}$	$ z > 0$

END OF EXAMINATION PAPER



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Mechatronics Engineering
Semester 3 Resit Final examination 2025

Module Code	:	EE2317
Module Title	:	Data Structures and Soft Computing
Date	:	2025.09.16
Time Allowed	:	09:00 - 12:00

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination. No reference materials are allowed.
- This paper consists of Five (5) Questions. Answer all questions.
- Use only the answer booklet provided and additional sheets for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on all sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question, consult the Supervisor or Invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.
- This paper contains Four (04) pages
- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.

Question 1:

Arrays and Linked Lists are both fundamental data structures in computer science.

- (a) Explain the concept of an array as a static data structure and a singly linked list as a dynamic data structure. (5 marks)
- (b) You are tasked with designing a system to rotate a sequence of integers to the right by one position (e.g., [10, 20, 30, 40] becomes [40, 10, 20, 30]).

Explain how you can achieve this task using:

- i. An array
- ii. A linked list

(2 × 5 = 10 marks)

Question 2:

- (a) Describe the structure of a Singly Linked List and a Stack. (5 marks)
- (b) Explain how a Stack can be implemented using a singly linked list, focusing on the operations of push (adding an element) and pop (removing an element). (10 marks)
- (c) Discuss one advantage and one disadvantage of this implementation compared to a Stack implemented using an Array. (5 marks)

Question 3:

- (a) Define a binary search tree (BST) and an undirected graph. Explain two key differences between them. (6 marks)
- (b) Discuss how Breadth-First Search (BFS) can be applied to both a BST and an undirected graph, including one similarity and one difference in their implementation. (6 marks)
- (c) You are designing a package delivery system. The system uses a BST to store parcel IDs in sorted order and an undirected graph to represent delivery routes between cities.
 - (i) Write pseudocode to delete a parcel ID from the BST while preserving the BST property. (4 marks)
 - (ii) Given an undirected graph with 6 nodes (A, B, C, D, E, F) and edges (A-B, A-C, B-D, C-E, D-F), write pseudocode to perform BFS starting from node A to find a path to node F. (4 marks)

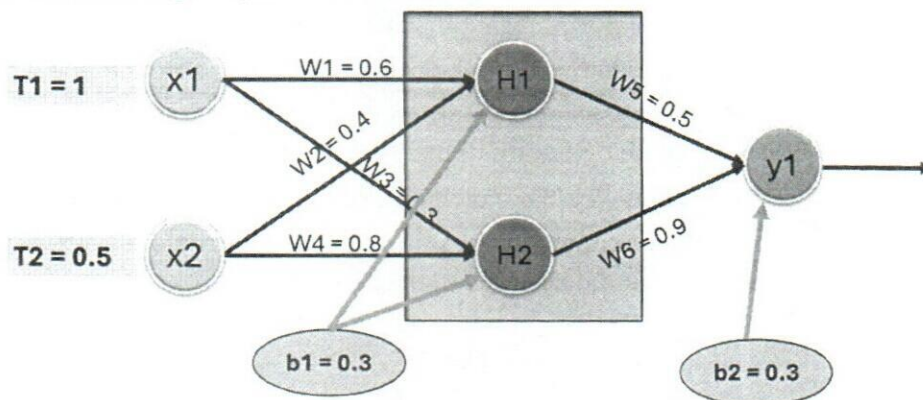
Question 4

Neural networks are widely applied in modern software systems.

(a) Explain the following terms:

- (i) Activation Function
 - (ii) Perceptron
 - (iii) Bias
 - (iv) Learning Rate
- (10 marks)

(b) Consider the following simple neural network:



Compute the outputs for H_1 , H_2 , and Y , showing all necessary steps. (10 marks)

Question 5

You are tasked with designing a workout plan from a list of exercises that satisfies the following criteria:

- The total time of the workout must not exceed 60 minutes.
- The goal is to maximize the total calories burned while staying within the time limit.
- The gym offers the following exercises:

Code	Exercise	Time minutes)	Calories burnt
E01	Running	20	200

E02	Weight Lifting	30	150
E03	Cycling	25	180
E04	Swimming	15	100
E05	Jump rope	10	120

Each individual in the population represents a possible combination of exercises (a workout plan). For example, an individual might be [Running, Swimming].

- What is a suitable genotype (chromosome representation) for this problem? (3 marks)
- Design a suitable Fitness Function for this problem. (3 marks)
- Carry out the first iteration of a genetic algorithm for this problem.
- Generate an initial population of 4 chromosomes. (4 marks)
- Select two parents for single-point crossover and produce one offspring. (4 marks)
- Apply a mutation operation to the offspring. (2 marks)
- Explain how you would conduct selection to form the next generation. (2 marks)
- Justify why your chosen fitness function is appropriate for guiding the algorithm towards the stated goal. (2 marks)

-----END OF PAPER-----



CINEC Campus
Faculty of Engineering and Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Batch 04 Semester 08 Re-Sit Examination 2025

Module Code : EE4322
Module Title : Microwave Engineering
Date : 30th August 2025
Examiners : Ms. Dushani Munasinghe
Time Allowed : 1.30PM – 04.30PM; 03hrs

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination. No reference materials are allowed.
- This paper consists of four (04) questions. Answer all questions.
- Use only the provided answer booklet, Smith Chart and additional sheets for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on all sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question, consult the supervisor or invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to above instructions.
- **This examination paper contains six (06) page**

Question 01

- (a) Explain in two (02) sentences why scattering parameters $[S]$ are preferred over impedance, $[Z]$ or admittance, $[Y]$ parameters at microwave frequencies.

(04 Marks)

- (b) A two-port microwave device has the following S -matrix:

$$S = \begin{bmatrix} 0.4\angle 0^\circ & 0.6\angle -90^\circ \\ 0.6\angle 90^\circ & 0.7\angle 0^\circ \end{bmatrix}$$

- (i) State whether the network is reciprocal. Give your reasons.
- (ii) Verify whether it is lossless. Give your reasons.
- (iii) If port 2 is terminated with a matched load, determine the return loss at port 1 (in dB).

(07 Marks)

- (c) A microwave network consists of two cascaded segments:

- Segment 1: A shunt admittance of $Y = j0.02 \text{ S}$.
- Segment 2: A lossless transmission line with $Z_0 = 75 \Omega$, electrical length $\beta l = 45^\circ$.

Construct the overall ABCD matrix of the system.

(08 Marks)

- (d) Write down three (03) commonly used rules for simplifying signal-flow graphs.

(06 Marks)

[Total - 25 Marks]

Question 02

- (a) State what is meant by impedance matching. Briefly mention two (02) techniques used in practice.

(06 Marks)

- (b) A transmission line with $Z_0 = 50 \Omega$ is terminated in $Z_L = 40 + j20 \Omega$. The line length is $\ell = 0.25 \text{ m}$, and the operating wavelength is $\lambda = 1.0 \text{ m}$. Calculate the input impedance Z_{in} .

(06 Marks)

- (c)
 - (i) State two differences between microstrip and stripline transmission lines.
 - (ii) A microstrip line is built on a substrate with $\epsilon_r = 4.0$, substrate thickness $d = 1.2 \text{ mm}$, and strip width $W = 2.5 \text{ mm}$. Using the empirical formula, estimate its characteristic impedance.

(07 Marks)

- (d) A lossless line with $Z_0 = 50 \Omega$ and length 0.25λ is terminated with $Z_L = 100 - j50 \Omega$. Using a Smith Chart, find:

- (i) Input impedance Z_{in}
- (ii) VSWR

(iii) Reflection coefficient magnitude $|\Gamma|$

(06 Marks)

[Total - 25 Marks]

Question 03

(a) A short-circuited $\lambda/4$ transmission line is used as a resonator.

- (i) Sketch and explain the voltage distribution along the line for the fundamental resonance.
- (ii) State briefly what the Q-factor represents in a resonator.
- (iii) Calculate the input impedance at resonance if $Z_0 = 50 \Omega$.
- (iv) If the attenuation constant is $\alpha = 0.02 \text{ Np/m}$ and frequency corresponds to $\beta = 40 \text{ rad/m}$, compute the Q-factor.

(08 Marks)

(b) What is the purpose of a slotted line in microwave measurements? Mention two quantities that can be measured using it.

(05 Marks)

(c) A directional coupler has input power $P_{in} = 10 \text{ dBm}$, coupling factor = 15 dB, directivity = 30 dB, and insertion loss = 1 dB. Assuming all ports are matched, calculate the power at,

- (i) through port,
- (ii) coupled port, and
- (iii) isolated port.

(06 Marks)

(d) Briefly describe the working principle of a reflex klystron oscillator. Highlight the role of the buncher and catcher cavities.

(06 Marks)

[Total - 25 Marks]

Question 04

(a) Gunn diodes are also used as negative-resistance devices.

- (i) Explain the principle of negative resistance in a Gunn diode (in 3 sentences).
- (ii) State one typical microwave application of a Gunn diode.

(07 Marks)

(b) Explain the operation of a varactor diode and mention one of its microwave applications. (Use not more than four (04) sentences)

(04 Marks)

- (c) Briefly explain the structural difference between an *Heterojunction Bipolar Transistor (HBT)* and a conventional *Bipolar Junction Transistor (BJT)*, and how this improves performance at microwave frequencies.
(Use not more than four (04) sentences)

(04 Marks)

- (d) A pyramidal horn antenna operates at $f = 12$ GHz. The aperture dimensions are $A_e = 100$ mm, $B_e = 50$ mm, and efficiency $\eta = 0.7$. Calculate the antenna gain in linear scale and dB scale.

(10 Marks)

[Total - 25 Marks]

Reference Equations

Shunt Admittance Y :

$$M_1 = \begin{bmatrix} 1 & 0 \\ Y & 1 \end{bmatrix}$$

Ideal transmission line:

$$M_2 = \begin{bmatrix} \cos(\beta l) & jZ_0 \sin(\beta l) \\ j\frac{1}{Z_0} \sin(\beta l) & \cos(\beta l) \end{bmatrix}$$

Phase constant:

$$\beta = \frac{2\pi}{\lambda}$$

Transmission line input impedance:

$$Z_{in} = Z_0 \cdot \frac{Z_L + jZ_0 \tan(\beta \ell)}{Z_0 + jZ_L \tan(\beta \ell)}$$

Microstripline:

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left(\frac{1}{\sqrt{1 + 12 \frac{d}{W}}} \right) ; Z_0 = \frac{120\pi}{\sqrt{\epsilon_{eff}} \left(\frac{W}{d} + 1.393 + 0.667 \ln \left(\frac{W}{d} + 1.444 \right) \right)}$$

$\lambda/2$ line resonator:

$$Z_{in} = Z_0 \cdot \tanh [(\alpha + j\beta)\ell] ; Q = \frac{\beta}{2\alpha}$$

Directional couplers:

$$C = 10 \log_{10} \left(\frac{P_{in}}{P_{coupled}} \right) \text{ dB} ; D = 10 \log_{10} \left(\frac{P_{coupled}}{P_{isolated}} \right) \text{ dB} ; I = 10 \log_{10} \left(\frac{P_{in}}{P_{isolated}} \right) \text{ dB}$$

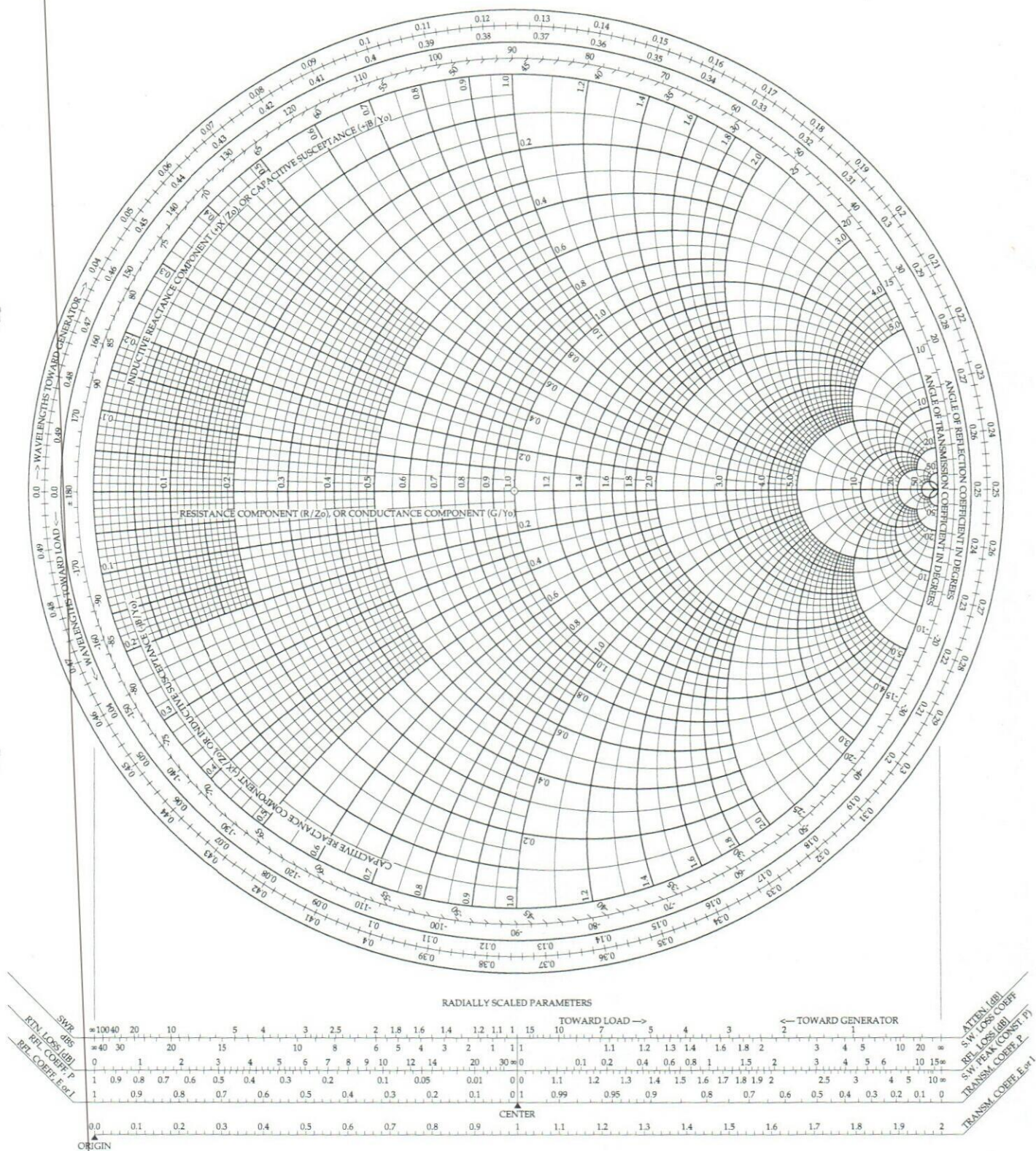
Horn antennas:

$$G = \eta \cdot \frac{4\pi A_e B_e}{\lambda^2}$$

-END OF EXAMINATION PAPER-

The Complete Smith Chart

Black Magic Design





Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc Hons (Eng) Electronic & Telecommunication Engineering /
Mechatronics Engineering / Automotive Engineering
Batch 7B Semester 1 First Sit Final Examination 2025
Batch 7A Semester 1 Re Sit Final Examination 2025

Module Code	:	EE1315
Module Title	:	Electricity
Date	:	23 rd August 2025
Examiner	:	Shasiprabha Mihihansi
Time Allowed	:	9.00 – 12.00 AM ; 03 hrs.

INSTRUCTIONS TO CANDIDATES:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of **five (05)** questions. Answer **ALL** questions.
- Use only the provided answer booklet and additional sheets for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on *all* sheets.
- **Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.**
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question, consult the supervisor or invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.
- The question paper contains eight (08) pages.
- You may use a scientific calculator. It must not be programmable. That may be examined during the examination.

Question 1

- (i). Answer the following questions considering the fundamentals of Electrical Engineering.
- a) Define AC and DC currents. (1 mark)
 - b) Recognize the importance of International System of Units (SI) in Electrical Engineering. (2 marks)
 - c) Define electromotive force (EMF) and potential difference (PD). Identify the difference between them. (3 Marks)
 - d) Calculate v_1 and v_2 in the circuit given in Figure 1. (4 Marks)
- (ii). Calculate the equivalent resistance of the circuit given in Figure 2. (5 marks)
- (iii). Calculate the equivalent capacitance of the circuit shown in Figure 3. (5 marks)

[Total 20 Marks]

Question 2

- (i). Answer the following paying attention to the circuit laws.
- a) State Kirchoff's current law. (3 marks)
 - b) Using Kirchoff's currents law and Kirchoff's voltage law, find i and v in the circuit given in Figure 4. (7 marks)
- (ii). Answer the following questions with particular emphasis on the circuit theorems.
- a) State the Superposition Theorem regarding dc circuit analysis. (3 marks)
 - b) For the circuit given in Figure 5, Calculate current i using superposition theorem. (7 marks)

[Total 20 Marks]

Question 3

(i). Answer the following questions regarding AC Theory.

a) Given the sinusoid $30 \sin(4\pi t - 75^\circ)$, calculate its

- (i) Amplitude,
- (ii) Phase,
- (iii) Angular frequency,
- (iv) Period and
- (v) Frequency.

(2 marks)

b) Calculate the phase angle between $v_1 = 10 \cos(\omega t + 50^\circ)$ and $v_2 = 12 \sin(\omega t - 10^\circ)$. Find which sinusoid is leading.

(3 marks)

c) Express the sinusoid $v = -10 \sin(2t + 40^\circ)$ V, using phasor domain representation.

(3 marks)

(ii). The current $i(t)$ drawn by a series connected single phase load and the applied voltage $v(t)$ are given by;

$$i(t) = 4 \cos(100\pi t + 100^\circ) \text{ A}$$

$$v(t) = 120 \cos(100\pi t - 200^\circ) \text{ V}$$

a) Calculate the

- Real power,
- Reactive power and
- The apparent power drawn by the load.

(4 marks)

b) Calculate the power factor of the load.

(2 marks)

c) Calculate the load impedance and the values of the elements that form the load.

(2 marks)

(iii). Calculate $v(t)$ and $i(t)$ in the circuit in Figure 6.

(4 marks)

[Total 20 Marks]

Question 4

(i). A moving-coil ammeter has a full-scale deflection current of 1 mA and an internal resistance of 50Ω . To extend its range to 0–10 mA, a suitable shunt resistor is connected in parallel with the meter.

a) Clarify why a shunt resistor is used to extend the range of an ammeter.

(2 marks)

b) Calculate the value of the shunt resistance required to convert the meter into a 0–10 mA ammeter.

(3 marks)

(ii). Answer the following questions based on your knowledge regarding Electrical Installations.

a) Clarify the reasons why the IT earthing system is not recommended for public electricity supply.

(2 marks)

b) Define the Earthing system used in Sri Lanka. Illustrate it using a suitable diagram.

(5 marks)

c) Describe the purpose and operation of a Residual Current Circuit Breaker (RCCB) in house wiring.

(4 marks)

d) Describe the function of a fuse and contrast the key difference(s) between a Miniature Circuit Breaker (MCB) and a fuse.

(4 marks)

[Total 20 Marks]

Question 5

(i). Answer the following considering your knowledge regarding magnetic fields.

a) Quote Lorentz force law.

(1 marks)

b) Describe the term magnetic Dipole.

(2 marks)

c) Compute the magnitude of the magnetic field of a long, straight wire carrying a current of 1A at distance of 1m from it. ($\mu_0 = 4\pi \times 10^{-7}$)

(4 marks)

(ii). Answer the following based on your knowledge about Electromagnetic Induction.

a) Quote Lenz's law.

(1 mark)

b) A transformer has 1000 turns on the primary winding and 250 turns on the secondary winding. If the primary voltage is 400 V, calculate:

i) The turns ratio of the transformer

(1 mark)

ii) The secondary voltage

(2 marks)

(iii). A coil of 200 turns is placed in a uniform magnetic field. The magnetic flux through the coil changes uniformly from 0.05 Wb to 0.00 Wb in 0.01 seconds.

a) Quote the Faraday's Law of electromagnetic induction.

(2 marks)

b) Calculate the induced emf in the coil.

(3 marks)

c) Indicate whether the induced current would be clockwise or counter-clockwise if the magnetic flux is decreasing into the page.

(4 marks)

[Total 20 Marks]

END OF QUESTION PAPER

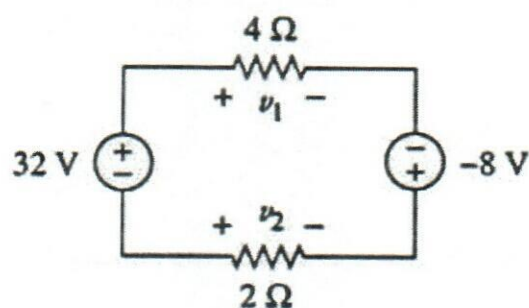
Annexure

Figure 1

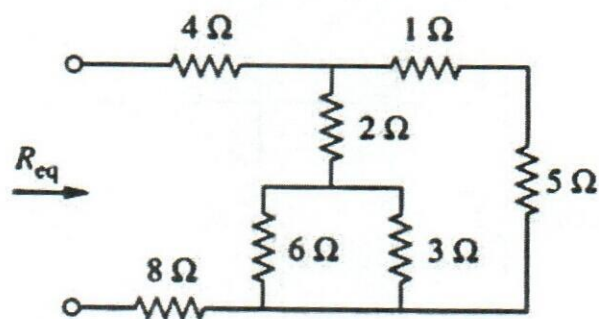


Figure 2

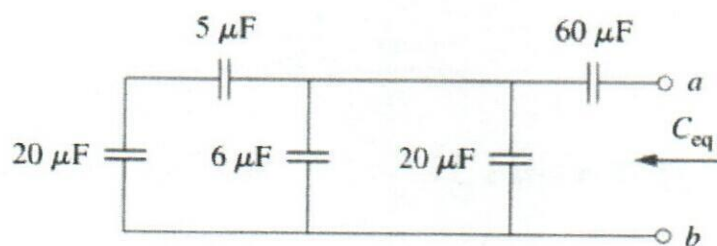


Figure 3

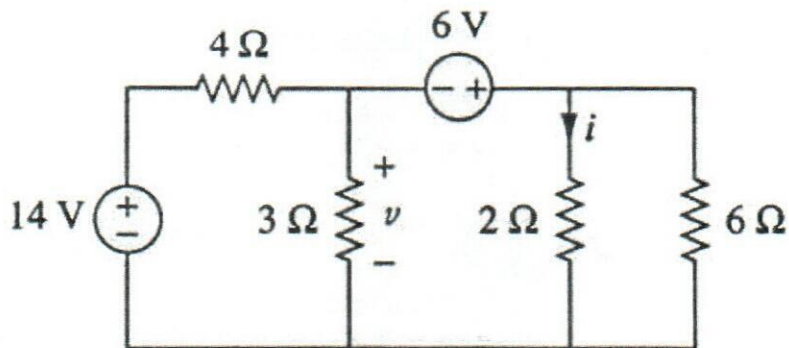


Figure 4

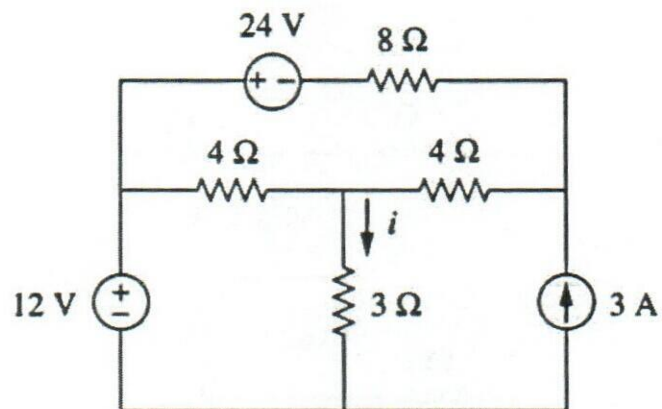


Figure 5

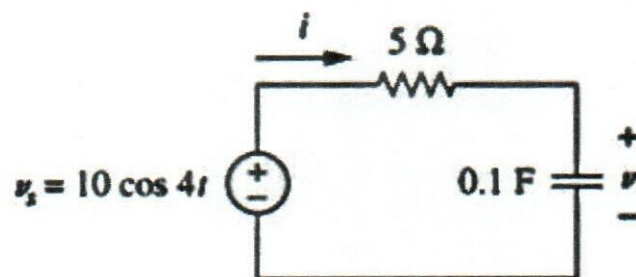


Figure 6

Equations

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\sin(\omega t \pm 180^\circ) = -\sin \omega t$$

$$\cos(\omega t \pm 180^\circ) = -\cos \omega t$$

$$\sin(\omega t \pm 90^\circ) = \pm \cos \omega t$$

$$\cos(\omega t \pm 90^\circ) = \mp \sin \omega t$$

$$P = V_{\text{rms}} I_{\text{rms}} \cos(\theta_v - \theta_i)$$

$$S = V_{\text{rms}} I_{\text{rms}}$$

$$R_n = \frac{I_m}{I_{fs} - I_m} R_m$$

$$\varepsilon = -N \times |d\Phi/dt|$$

$$B = (\mu_0 I) / (2 \pi r)$$



Faculty of Engineering and Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Mechatronic Engineering
Semester 4 Re-Sit - Final Examination 2025

Module Code : EE4316
Module Title : Image Processing and Machine Vision
Date : 20th Aug 2025
Examiners : Mr. Sanath Thilakarathna
Time Allowed : 03 Hours

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of twenty five (25) multiple choice (mcq) questions and three (03) essay question.
- Use only the provided answer booklet, additional sheets, and graph papers for your answers.
- Mark mcq answers on provided mcq answer sheet, and write answers for essay questions on provided answer booklet.
- Attach the mcq answer sheet to the answer booklet securely.
- Write clearly and legibly using a blue or black pen.
- Write your student number on all sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator, or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.

Section I: Multiple Choice Questions

Each question carries one (01) mark.

1. Which filter is best suited for edge detection?
 - (a) Gaussian filter
 - (b) Median filter
 - (c) Sobel filter
 - (d) Low-pass filter
2. The Fourier Transform is primarily used in image processing for:
 - (a) Histogram equalization
 - (b) Frequency domain analysis
 - (c) Pixel interpolation
 - (d) Noise modeling
3. The Canny edge detector is characterized by:
 - (a) Frequency domain analysis
 - (b) Simple thresholding only
 - (c) Multi-stage detection including non-maximum suppression
 - (d) Poor localization
4. Which algorithm is most commonly used for corner detection?
 - (a) Harris detector
 - (b) Median filter
 - (c) PCA
 - (d) K-means
5. The K-means algorithm in image processing is mainly used for:
 - (a) Contrast enhancement
 - (b) Image segmentation
 - (c) Histogram stretching
 - (d) Edge sharpening
6. The Hough Transform is effective for detecting:
 - (a) Shapes such as lines and circles
 - (b) Histogram peaks
 - (c) Image scaling
 - (d) Noise patterns

7. The main disadvantage of the Laplacian operator in edge detection is:
 - (a) Requires Fourier transform first
 - (b) High sensitivity to noise
 - (c) Detects only vertical edges
 - (d) Cannot detect any edges
8. Compared to the Sobel operator, the Canny edge detector provides:
 - (a) Better edge localization and noise suppression
 - (b) Only vertical edge detection
 - (c) Lower accuracy in edge detection
 - (d) Higher computational speed but poor accuracy
9. In image compression, lossless methods (e.g., PNG) are preferred over lossy when:
 - (a) Exact image recovery is essential
 - (b) File size must be extremely small
 - (c) Storage space is unlimited
 - (d) Processing speed is more important
10. Compared to histogram equalization, adaptive histogram equalization (CLAHE):
 - (a) Improves local contrast in small regions
 - (b) Produces lower contrast enhancement
 - (c) Works uniformly on the entire image
 - (d) Requires no computation
11. Which of the following is an advantage of frequency domain filtering?
 - (a) Simpler interpretation
 - (b) Faster convolution using FFT
 - (c) Less memory always
 - (d) Better pixel visualization
12. Compared to PCA, Linear Discriminant Analysis (LDA) is better suited for:
 - (a) Histogram smoothing
 - (b) Image compression only
 - (c) Feature extraction with supervised classification
 - (d) Unsupervised dimensionality reduction
13. One drawback of k-means clustering in image segmentation is:
 - (a) Requires predefining the number of clusters
 - (b) Cannot process grayscale images
 - (c) Produces exact boundaries always
 - (d) Works only for color images

14. In medical imaging, image segmentation is critical for:
- (a) Detecting tumors or anatomical structures
 - (b) Increasing pixel density
 - (c) File format conversion
 - (d) Reducing storage size
15. In automated inspection, a thresholding algorithm can be used to:
- (a) Compress the image
 - (b) Separate defective and non-defective items
 - (c) Enhance illumination
 - (d) Change image resolution
16. License plate recognition systems primarily rely on:
- (a) Edge detection and character recognition
 - (b) Histogram smoothing only
 - (c) Frequency filtering
 - (d) Morphological erosion only
17. In face recognition, eigenfaces are generated using:
- (a) Convolutional Neural Networks
 - (b) Median filtering
 - (c) PCA for dimensionality reduction
 - (d) Hough transform
18. An application where texture analysis is most useful is:
- (a) Reducing image resolution
 - (b) Identifying cracks on surfaces
 - (c) Changing file formats
 - (d) Measuring brightness
19. Which image processing technique is critical for autonomous vehicles?
- (a) Background subtraction
 - (b) Image compression
 - (c) Edge detection and object recognition
 - (d) Histogram stretching
20. TensorFlow and PyTorch are widely used in machine vision for:
- (a) Noise filtering
 - (b) Machine learning and deep learning
 - (c) Histogram equalization
 - (d) Image compression

21. In a machine vision system, CNNs (Convolutional Neural Networks) are most commonly used for:
- (a) Object detection and classification
 - (b) Thresholding only
 - (c) Histogram smoothing
 - (d) Image compression
22. The ImageNet dataset is widely used for:
- (a) Studying Fourier transforms
 - (b) Benchmarking image classification algorithms
 - (c) Reducing training image resolution
 - (d) JPEG compression
23. Which machine learning algorithm is most appropriate for supervised image classification?
- (a) Histogram equalization
 - (b) Support Vector Machines (SVM)
 - (c) PCA
 - (d) K-means
24. In deep learning, transfer learning is used when:
- (a) Fourier transforms are required
 - (b) Training a model from scratch is not feasible
 - (c) Histograms need equalization
 - (d) Segmentation must be unsupervised
25. Which library provides pre-trained models for vision tasks such as object detection?
- (a) MATLAB Image Processing Toolbox
 - (b) TensorFlow Hub
 - (c) OpenCV
 - (d) FFTW

[Total - 25 Marks]

Section II – Essay Questions

Question 1

- (a) Explain the purposes of the activation layer in neural networks and name two activation functions. (04 Marks)
- (b) State one (1) pre-trained neural network for each of the following machine vision tasks:
- i. Image classification
 - ii. Object detection
 - iii. Instance Segmentation
 - iv. Keypoint Detection (04 Marks)
- (c) Explain what is transfer learning and how it differ from general machine learning. (04 Marks)
- (d) Describe three key benifit of transfer learning. (03 Marks)
- (e) During a training process, the following was logged per epoch :
- Epoch 1: train loss 1.20, val loss 1.18, train mAP 0.41, val mAP 0.40
Epoch 5: train loss 0.72, val loss 0.83, train mAP 0.58, val mAP 0.51
Epoch 10: train loss 0.46, val loss 1.02, train mAP 0.68, val mAP 0.45
Epoch 15: train loss 0.28, val loss 1.19, train mAP 0.76, val mAP 0.39
- Identify the issue, give the likely cause, and state two corrective actions. (04 Marks)
- (f) Define and explain the purpose of the following performance metrics in binary classification:
- i. Precision
 - ii. Recall
 - iii. Accuracy (06 Marks)

[Total - 25 Marks]

Question 2

An optical mouse works by illuminating the surface with an LED/laser and capturing thousands of very low-resolution frames per second with a tiny CMOS sensor. An on-chip processor compares successive frames to estimate Δx , Δy counts (CPI = counts per inch). Tracking degrades if frames blur, the surface lacks texture, the sensor lifts too far from the surface, or glare saturates pixels. This is how an optical mouse works.

- (a) Explain how the optical mouse estimates Δx , Δy from successive frames, describing the roles of the illuminator, image sensor, and on-chip processing. (05 Marks)
- (b) At 1600 CPI, how many millimetres per count? (1 inch = 25.4 mm) (02 Marks)
- (c) A mouse moves at 0.5 m/s and the sensor runs at 2000 fps. Estimate the pixel/count shift per frame (assume 1 count $\approx$ 1 pixel) (04 Marks)
- (d) List three factors that degrade tracking and give one mitigation for each. (06 Marks)

- (e) This principle can be applied to drones navigation (optical-flow navigation), explain how to estimate horizontal velocity over ground using a downward-facing optical-flow camera. (06 Marks)
- (f) State two situations where optical flow becomes unreliable and explain why. (02 Marks)

[Total - 25 Marks]

Question 3

- (a) Evaluate what the following terms mean
- i. Image segmentation
 - ii. Image classification
 - iii. Object detection
 - iv. Instance segmentation (04 Marks)
- (b) Describe how data is annotated during transfer learning for the following 2 cases
- i. Depth Estimation
 - ii. Instance segmentation (02 Marks)
- (c) Explain how instance segmentation is used as an aid for annotating datasets for detection tasks. (02 Marks)
- (d) Describe what is meant by Zero-shot classification, and its key advantage over traditional classifiers. (03 Marks)
- (e) State 3 examples of open-source neural network models which can be used for zero-shot classification. (02 Marks)
- (f) Explain the process of developing a custom machine vision workflow and serving it as a cloud-hosted API using Roboflow. (03 Marks)
- (g) Describe how a program running on a computing device calls a Roboflow inference end point. (04 Marks)
- (h) State what is meant by edge inferencing, and why it is sought after than cloud-hosted API endpoints (02 Marks)
- (i) State 3 hardware platforms which can be used for edge inferencing, and provide a brief description for each. (03 Marks)

[Total - 25 Marks]

-End of Examination Paper-



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Batch 5 Semester 5 Re-Sit Final Examination 2025

Module Code	:	EE3312
Module Title	:	Communication II
Date/Time	:	10 th August 2025/ 0900-1200h
Examiners	:	Srimal Punchihewa
Time Allowed	:	3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination. No reference materials are allowed.
- This paper consists of four (04) questions. Answer all questions.
- Use only the provided answer booklet and additional sheets, for your answers.
- Write clearly and legibly using a blue or black pen.
- Write your student number on all sheets.
- **Start each question on a new page in the answer booklet.** Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.
- This examination paper contains five (05) pages.

1.

i) Elaborate "FSK" modulation technique considering the way digital signals are transmitted.

(3 marks)

ii) A sketch of Baseband PAM signal is shown in Fig 1(i)

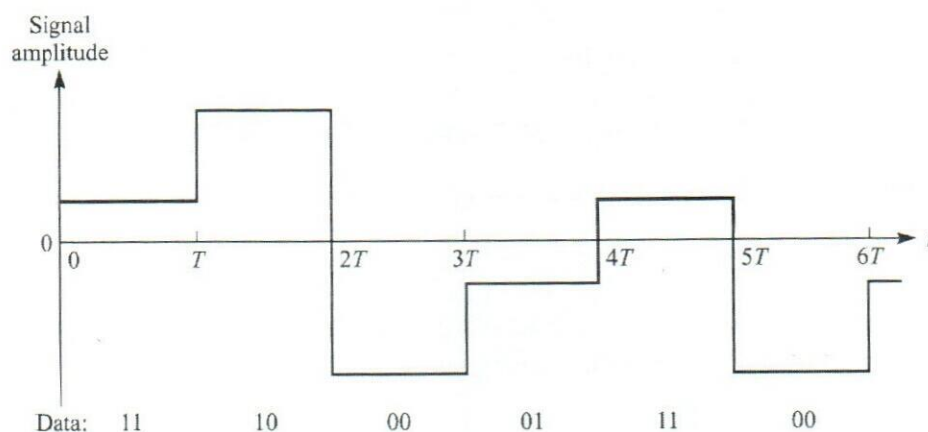


Fig 1(i)

Develop bandpass PAM signal for this baseband signal and sketch it.

(4 Marks)

iii) Signal space diagram for BPSK signal is shown in Fig 1(ii)

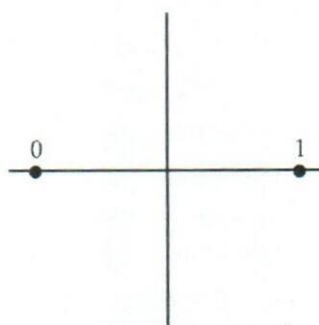


Fig 1(ii)

Develop and sketch signal space diagrams for QPSK and 8-PSK signals.

(4 Marks)

iv) Evaluate the baud and minimum bandwidth necessary to pass a 10 kbps binary signal using amplitude shift keying. ($M = 2$)

(5 marks)

v) Evaluate

- (a) the peak frequency deviation,
- (b) minimum bandwidth, and
- (c) baud

for a binary FSK signal with a mark frequency of 49 kHz, a space frequency of 51 kHz, and an input bitrate of 2 kbps.

(9 marks)

(Total 25 marks)

2.

i) Elaborate AWGN and briefly explain each term.

(5 marks)

ii) Optimal Receiver in AWGN channel is shown in Fig 2(i)

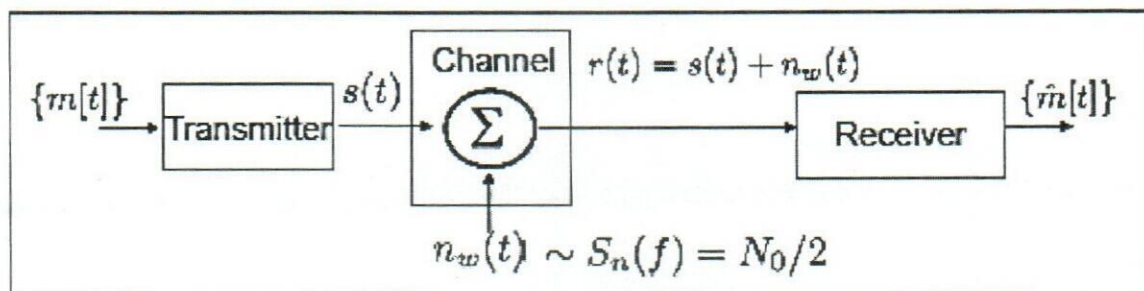


Fig 2(i)

(a) Interpret the difference between $\{m(t)\}$ and $\{\hat{m}(t)\}$.

(3 marks)

(b) Interpret $S_n(f)$.

(3 marks)

(c) Hypothesize why the expression $r(t) = s(t) + n_w(t)$ is possible.

(3 marks)

iii) The structure of an optimal receiver is shown in Fig 2(ii)

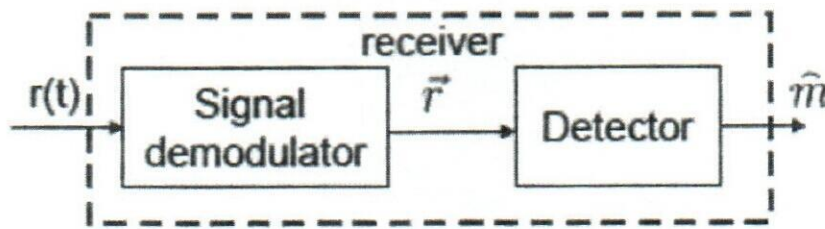


Fig 2(ii)

Analyse the functions of signal demodulator and detector.

(6 marks)

iv) In an optimal receiver in AWGN channel, transmitter transmits a sequence of symbols or messages from a set of M symbols $m_1, m_2, \dots, m_M$ with prior probabilities.

Elaborate "prior probabilities".

(5 marks)

(Total 25 marks)

3.

i) Elaborate multi carrier modulation in brief.

(5 marks)

ii) Evaluate the advantages of multi carrier modulation.

(3 marks)

iii) In multi-carrier modulation, as individual subcarriers are overlapping, interpret how interference between carriers is avoided.

(5 marks)

iv) Elaborate the operation of OFDM modulation technique using a diagram.

(7 marks)

v) Reason the advantages and disadvantages of OFDM modulation technique.

(5 marks)

(Total 25 marks)

4. Spread spectrum is used to make transmissions more secure, reduce interference, and improve bandwidth sharing.
- i). Discuss the operation of spread spectrum system using a suitable diagram.
(7 marks)
 - ii) Discuss the Frequency Hopping Spread Spectrum (FHSS) operation.
(6 marks)
 - iii) Discuss an FHSS transceiver model using a suitable diagram and explain its operation.
(6 marks)
 - iv) Discuss Direct Sequence Spread Spectrum (DSSS) transceiver model using a suitable diagram and explain its operation.
(6 marks)
- (Total 25 marks)

END OF THE EXAMINATION PAPER



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical & Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Semester 05 Re-sit Examination 2025

Module Code	:	EE3315
Module Title	:	Digital Systems Design
Date	:	2025.08.03
Examiners	:	Mr. Athula Seneviratne
Time Allowed	:	03 hrs

- This is a **closed book** examination.
- This paper consists of two parts. Both parts must be answered:
 - **Part 'A'** contains forty (40) questions of the Multiple-Choice type. **All** questions carry **equal** marks. You should answer **ALL** questions.
 - **Part 'B'** contains two (02) descriptive type questions. Both questions carry equal marks. You should answer **BOTH** questions.
- Mark/Write your answers clearly and legibly with a **blue** or **black** pen.
- Use only the **CINEC MCQ Answering Sheet** provided to answer Part 'A' and only the **CINEC Answering Booklet** to answer Part 'B'. Additional sheets may be requested from the invigilators.
- This paper contains eleven (11) pages including this page.
- All papers used to perform rough work / draft calculations must be attached to the answer sheet and submitted.

MATERIAL REQUIRED

- CINEC MCQ Answering Sheet, CINEC Answering Booklet, and paper for carrying out rough work.
- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.

Part – A

This part contains 40 multiple-choice questions. Each question has 4 answers. You are required to select the **most correct** answer for each question and indicate it on the answer sheet provided, by marking a cross (X) across the selected answer.

- 01 Which of the following statements about synchronous and asynchronous sequential circuits **is incorrect** ?
- a. In asynchronous sequential circuits, state transitions are synchronized by a clock input
 - b. In asynchronous sequential circuits, state transitions are directly caused by the inputs
 - c. Synchronous circuits do not suffer from race hazards
 - d. Microcontrollers are examples of synchronous sequential circuits
- 02 Which of the following is **not** an example for 'the state' of a sequential system?
- a. Contents on the display of an electronic calculator
 - b. CAPS LOCK indicator on a computer keyboard
 - c. The 'channel' a car stereo set with pushbuttons is tuned to
 - d. The digit combination on a combinational lock
- 03 Which of the following is a hardware description language?
- a. C++
 - b. Verilog
 - c. Python
 - d. MIPS assembly language
- 04 Which of the following statements about Hardware Description Languages (HDL) is **incorrect**?
- a. Can be used to generate the PnR map for an LSI chip
 - b. Has syntax and structure
 - c. Does not support iteration (looping)
 - d. Supports branching
- 05 What is a difference between HDL and other high-level languages?
- a. In HDL, concurrent execution of statements is possible
 - b. In HDL, execution is sequential from top to bottom
 - c. HDL programs do not require compilation
 - d. HDL is tied to a particular processor
- 06 What is the end product of a correctly compiled HDL program?
- a. Simulation file
 - b. Bytecode
 - c. Netlist
 - d. PnR map

Refer to the VHDL script given in Figure 1, to answer questions 07 and 08:

```
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;

-- Define the entity AAA1
entity AAA1 is
  Port (
    A, B, C, D      : in STD_LOGIC;  -- inputs
    Y               : out STD_LOGIC   -- outputs
  );
end AAA1;

-- Define the architecture of entity 'AAA1'
architecture Be_AAA1 of AAA1 is
begin
  Y <= NOT(A AND B AND C AND D);
end Be_AAA1;
```

Figure - 1

- 07 What is the type of inputs used by the entity 'AAA1'?
- 4 independent bytes
 - 4 independent single bits
 - A 4-bit standard logic vector
 - None of the above
- 08 What is the logic element being implemented by this VHDL code?
- 4-bit Full Adder
 - 4-input NAND gate
 - 4-input AND gate
 - 4 x 1 line binary multiplexer
- 09 The twin circuits in Figure – 2 illustrates the operation of
- A flipflop
 - An amplifier
 - A logic inverter
 - A tri-state buffer

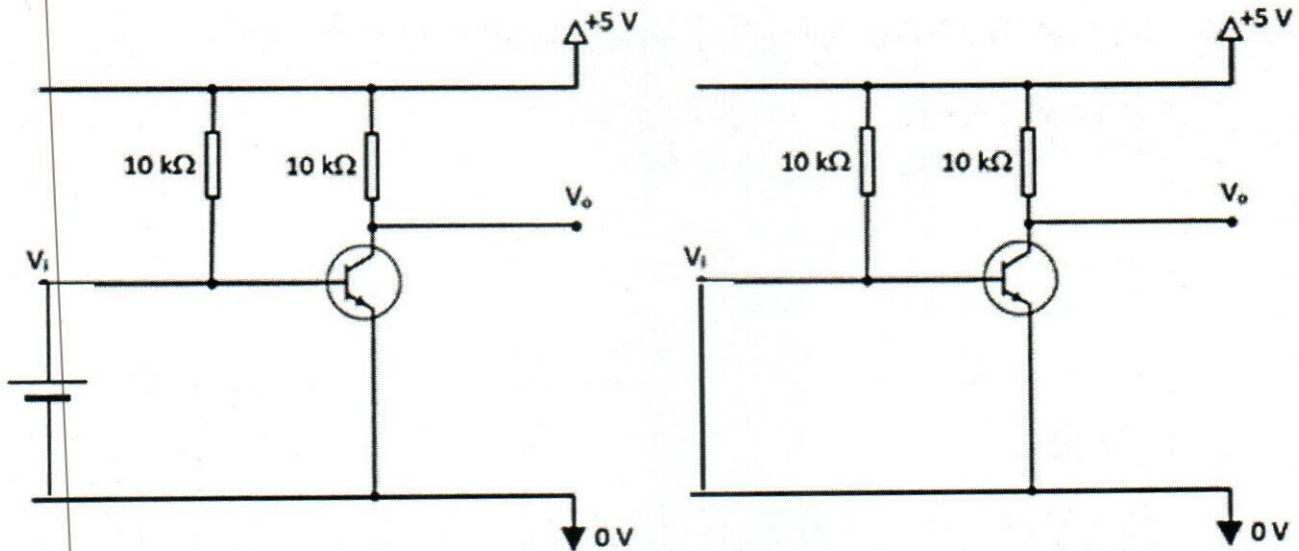


Figure - 2

- 10 When an instruction is loaded onto the Instruction Register (IR), the bits in the 'op-code' field become inputs to the
 - a. Flag register
 - b. Arithmetic and Logic unit
 - c. Control unit
 - d. Register file

- 11 A Register Transfer Language (RTL) is used to describe
 - a. the data flow between modules of a digital system
 - b. Resister Transistor logic circuit operation
 - c. how low-level hardware components work in a circuit
 - d. None of the above

- 12 Which of the following statements is **incorrect** ?
 - a. The op-code field of the instruction will uniquely define what would happen within the microprocessor during execution
 - b. The control unit never receives any inputs from the operand field of the instruction
 - c. The control unit is a sequential circuit
 - d. For a given op-code, the control unit will produce a unique set of waveforms

- 13 What constitutes the greater part of the design of a microprocessor?
 - a. Design of the Arithmetic and Logic Unit
 - b. Design if the Flag Register
 - c. Design of the RAM
 - d. Design of the control unit

- 14 The difference between a 'compiler' and an 'assembler' mainly lies in their
- sizes
 - Associated processors
 - Input sources
 - outputs
- 15 An advantage of using centralized control is
- The overall operation will be faster
 - It reduces the number of interconnections
 - It results in a single point of failure for the system
 - All control signals may be synchronized
- 16 Which of the following is **not** done during standard sequential circuit design?
- Identifying the inputs required to cause the state transitions
 - Defining the states
 - Eliminating lock-ins
 - Reducing the pin-out of the integrated circuit
- 17 Power islands are used to
- speed up the operation of a microprocessor
 - store intermediate data during the execution cycle in a microprocessor
 - reduce the power consumption of the microprocessor
 - optimize the silicon real-estate during manufacture of a microprocessor
- 18 Which of the following statements regarding 'interrupts' is **incorrect**?
- They freeze the operation of the microprocessor
 - They are used to make the system respond to external events
 - They alter the flow of normal execution of the program
 - They require an 'interrupt service routine' to work
- 19 The instruction format of a certain microprocessor has a 7-bit op-code field. What could be the possible size of the instruction set?
- 256
 - 115
 - 1023
 - 511
- 20 What is the correct sequence of phases during a single machine cycle in a microprocessor?
- Decode-fetch-execute
 - Fetch-decode-execute
 - Decode-execute-fetch
 - None of the above

- 21 In a pipelined microprocessor,
- Execute phase of two consecutive machine cycles may overlap
 - Fetch phase of two consecutive machine cycles may overlap
 - Fetch phase of the next machine cycles commences during the Decode phase of the current machine cycle
 - Fetch phase of the next machine cycles commences during the Execution phase of the current machine cycle
- 22 Which of the following is **not necessarily** a characteristic of an RISC processor?
- Low power consumption
 - High execution speed
 - Large register file
 - Small instruction set

```
for i in range(100):  
    root[i] = square_root(i)  
    prime_flag[i] = is_prime(i)
```

Figure – 3

Figure – 3 shows 3 consecutive lines of a Python script. The shown lines build 2 arrays to store the positive square root and a binary indication whether the number is a prime number, for all integers from 0 to 99, by calling two functions. The function `square_root()` returns the positive square root of the number passed to it. The other function is `is_prime()` returns '1' if the number passed is a prime number and '0' if it is not. This script is compiled for execution in a computing machine that uses an RISC processor having 48 registers. The compiler assigns registers to variables in the program in the manner shown in Figure - 4.

- 23 Which of the following registers is **most likely** to store the variable 'i' during program execution?
- R5
 - R10
 - R21
 - R40
- 24 As far as the 3 lines of code shown in Figure – 3 are concerned, are the allocation of the registers R10 through R19 shown in Figure – 4 useful, and why?
- No, because the indexing variable 'i' is an integer that does not require so many registers for storage
 - No, because there are no variables local to the function `is_prime()`
 - Yes, because there are variables local to the function `is_prime()`
 - Yes, because there are variables local to the function `square_root()`

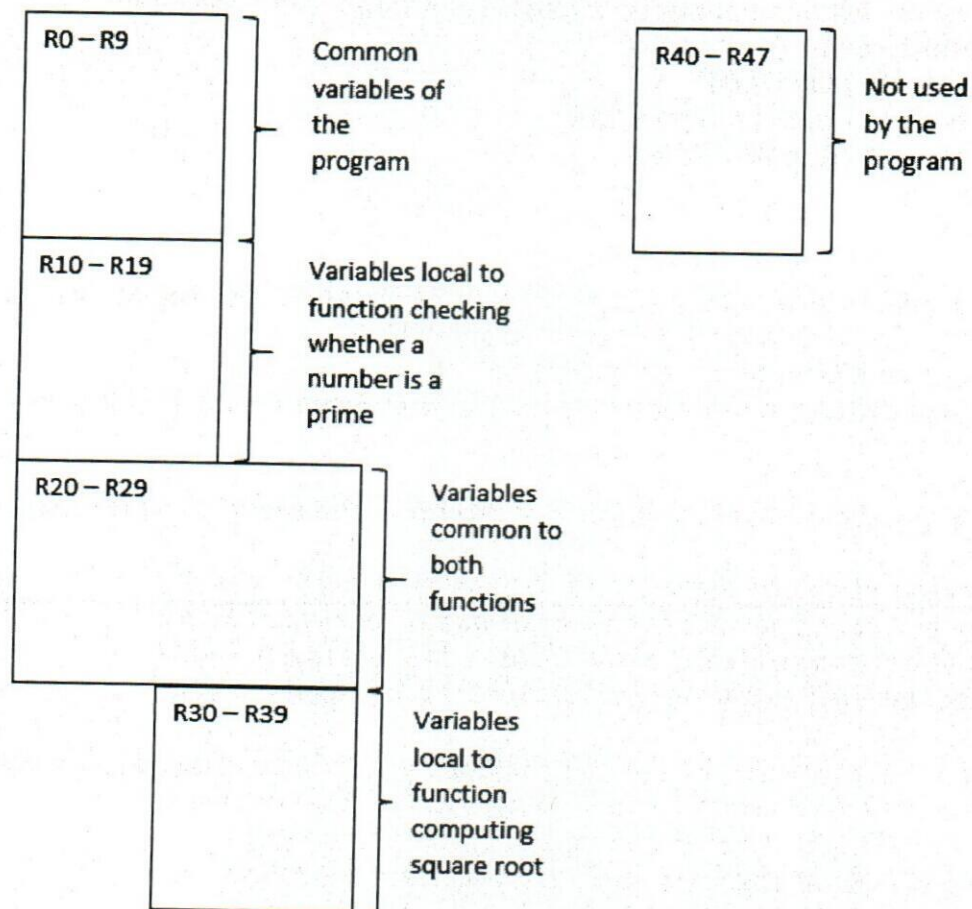


Figure – 4

- 25 How many registers are allocated for the execution of this script?
- 40
 - 30
 - 20
 - 10
- 26 What is the technique used in an RISC processor as illustrated in Figure – 4 called?
- Register mapping
 - Register organization
 - Register windowing
 - Register re-naming
- 27 Which of the following systems/devices is **most likely** to use an RISC processor?
- Servers
 - Notebook computers
 - Embedded systems
 - Gaming machines

- 28 Which of the following is **not** an example of a Read Only Memory?
- Level-2 cache
 - Programmable ROM
 - Erasable Programmable ROM
 - Electrically Alterable ROM
- 29 Cache memory were invented to
- increase overall memory capacity of the microprocessor-based system
 - store critical data during sudden power failures
 - serve as a backup for the onboard RAM
 - bridge the gap in the operating speeds of processors and memory chips
- 30 Choose the list of memory devices arranged in the order of **increasing** capacity, left to right
- Level-1 cache, external cache, level-2 cache, regular RAM
 - Level-1 cache, level-2 cache, external cache, regular RAM
 - External cache, level-2 cache, level-1 cache, regular RAM
 - Regular RAM, external cache, level-2 cache, level-1 cache
- 31 Choose the list of memory devices arranged in the order of **increasing** speed, left to right
- Regular RAM, external cache, level-1 cache, level-2 cache
 - Regular RAM, external cache, level-1 cache, registers
 - Regular RAM, registers, level-1 cache, external cache
 - Regular RAM, external cache, registers, level-1 cache
- 32 How many data pins are there in a single dynamic RAM chip?
- 16
 - 8
 - 1
 - None of the above

A microprocessor based single board device requires a 2 MB x 16-bit RAM. Answer the questions from 33 to 35.

- 33 The size of the address bus of this board is **most likely** to be
- 21 bits
 - 16 bits
 - 8 bits
 - 1 bit
- 34 The number of data pins of the microprocessor used in this board is **most likely** to be
- 1
 - 4
 - 8
 - 16

- 35 How many dynamic RAM chips are likely to be used in parallel on this board?
- 2
 - 8
 - 16
 - 32
- 36 Which of the following is the most suitable choice as the 'entity' when designing a dynamic RAM chip using VHDL?
- NAND gate
 - NOR gate
 - 1-bit memory cell
 - JK flip flop
- 37 In VHDL development packages, a difference between '**functional simulators**' and '**timing simulators**' is that
- the functional simulator uses the actual PnR map to produce the simulation
 - the timing simulator permits the examination of propagation delays through circuit elements
 - the timing simulator uses the actual netlist to produce the simulation
 - The timing simulator only provides a way of checking the designed circuit for its correct 'logic functionality'.
- 38 Which of the following is a practical example of a synchronous system?
- Microprocessor of the CISC type
 - Passenger counter on the embarkation ramp in a parked aircraft
 - Objects counter on a conveyor belt in a production line
 - Push-button attendance recorder
- 39 What is the purpose of using the '**process**' statement in VHDL scripts?
- To force a particular order of execution of the lines in the script
 - To define the architecture for an entity
 - To define the signals that are internally used in a sequential system
 - To call and execute another VHDL script
- 40 Which statement correctly describes a difference between a register and a RAM location?
- Accessing a RAM location is faster than accessing a register
 - Registers are located on the bus outside the processor
 - Bit level access is possible on a RAM location
 - Bit level access is possible on a register

Part – B

Question 1

- (i) Write down the truth table for a 3 input 'Majority Vote' circuit where the output is '1' whenever at least 2 out of the 3 inputs are '1'.
[5 marks]
- (ii) By intuition, write an expression for a Boolean function that implements the truth table written in response to 'i' above.
[5 marks]
- (iii) Considering any 2 appropriate lines of the truth table, verify that the function written in response to 'ii' above is correct.
[5 marks]
- (iv) Write the code for a VHDL program that implements the function written in response to 'ii' above. Your code should include the importation of necessary libraries and the definition of the entity – architecture pair.
[15 marks]

Question 2

Study the part of the VHDL script given in Figure – 5 and answer the following questions;

```

28  -- Import the necessary libraries
29  library IEEE
30  use IEEE.STD_LOGIC_1164.ALL;
31
32  -- Define the entity E1
33  entity E1 is
34  port(
35      E, S0, S1    : in STD_LOGIC;
36      X0, X1, X2, X3 : in STD_LOGIC;
37
38      Y           : out STD_LOGIC
39  );
40  end E1;
41
42
43  -- Define the architecture for the entity 'E1'
44  architecture ElBehavior of E1 is
45      -- Define the internal signals
46      signal C0, C1, C2, C3 : STD_LOGIC
47
48  begin
49      FBN0: entity work.E0 port map (E, NOT(S0), NOT(S1), X0, C0);
50      FBN1: entity work.E0 port map (E, S0, NOT(S1), X1, C1);
51      FBN2: entity work.E0 port map (E, NOT(S0), S1, X2, C2);
52      FBN3: entity work.E0 port map (E, S0, S1, X3, C3);
53      FBN4: entity work.E0D port map (C0, C1, C2, C3, Y);
54  end ElBehavior;
55

```

Figure - 5

- (i) Identify 2 errors in the lines of code given.
[5 marks]
- (ii) Explain the purpose of the 'internal signals' included in the architecture
[5 marks]
- (iii) Assuming that the entity E0 is a 4-input NAND gate defined earlier in the script and not shown in the Figure - 5, identify the function implemented by the code shown in Figure - 5 and write its Boolean expression. Show all steps used for the identification.
[20 marks]

[End of Examination Paper]



Faculty of Engineering and Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Automotive Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
BSc Hons (Eng) Mechanical Engineering
BSc Hons (Eng) Mechatronics Engineering
Semester 6 First-Sit - Final Examination 2025

Module Code : EE3324
Module Title : Control Systems
Date : 30th June 2025
Examiners : Mr. Randeera Liyanage
Time Allowed : (09:00 - 12:00) 3 hrs

Instructions to Candidates:

- This is a closed book examination. No reference materials are allowed.
- This paper consists of four (04) questions. Answer all four questions.
- Use only the provided answer booklet, additional sheets, and log-linear sheet for your answers.
- Attach the log-linear sheet to the answer booklet.
- Write clearly and legibly using a blue or black pen.
- Write your student number on all sheets.
- Start each question on a new page in the answer booklet. Clearly indicate the question number at the top of the page.
- If parts of the same question are written discontinuously in different sheets, ensure that each part is appropriately labelled with its corresponding question number.
- Where appropriate, include clear diagrams or sketches. These can aid in calculations and help convey your answers effectively.
- If you are unsure about the wording of a question consult the Supervisor or Invigilator, or make reasonable assumptions. Clearly state such assumptions in your answer script.
- Marks will be deducted for missing or incorrect measuring units, and failure to adhere to the above instructions.

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Q1 (25 Marks)

- (i) Using mathematical modeling, derive the transfer function for the rotational spring-mass-damper system illustrated in Figure 1. The system's input is torque of $T(t)$ and output is an angular displacement ($\theta(t)$). Following this, substitute the given system parameters and express the resulting transfer function in standard form.
($J = 5 \text{ kgm}^2$; $b = 24.5 \text{ Nsm}^{-1}$; $k = 60 \text{ Nm}^{-1}$) (5 Marks)
- (ii) Using the standard transfer function developed in part (a), calculate the Rise Time (T_R), Settling Time (T_S), Time to First Peak (T_P) and Percentage Overshoot (T_P) system characteristics. (6 Marks)
- (iii) Based on the transfer function obtained in Part (a), construct the corresponding pole-zero diagram. (4 Marks)
- (a) Describe the system's stability with respect to the pole locations in the diagram. (3 Marks)
- (b) Describe the nature of the system's oscillations. (3 Marks)
- (iv) Calculate the angle (θ) that defines the line of constant damping ratio within the pole-zero diagram constructed in Part (iii). Hence, describe the effects of varying the damper's damping coefficient on the system's response. (4 Marks)

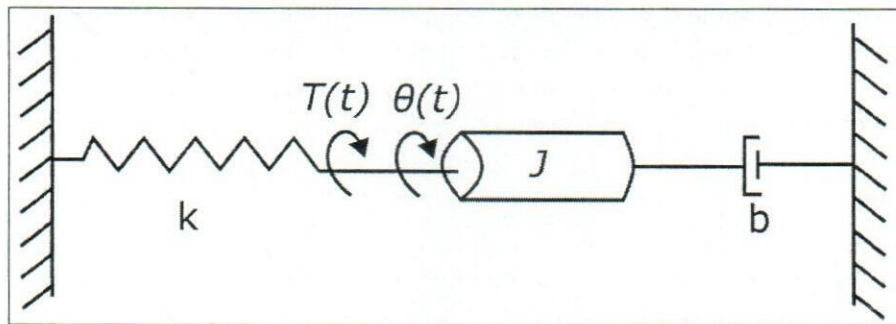


Figure 1: Rotational spring-mass-damper system.

Q2 (25 Marks)

- (i) Describe why system stability is crucial in an application such as an elevator control, with reference to the basic types of stability. (03 Marks)
- (ii) Determine the stability of the system given in Equation 1 using the Routh-Hurwitz stability criterion. Hence, state the number of poles that are in the right-hand side, left-hand side and in the imaginary axis.

$$s^6 + s^5 + 5s^4 + s^3 + 2s^2 - 2s - 8 = 0 \quad (1)$$

(07 Marks)

- (iii) Figure 2 represents the closed-loop block diagram of an RCL (resistor-capacitor-inductor) low-pass filter.
 - (a) Derive the closed-loop transfer function and determine the settling time T_S followed by the steady-state error (e_{ss}) for a unit step input. (05 Marks)
 - (b) In an effort to enhance the system's response, a proportional controller with a gain of 5 is incorporated into the original system. Draw the modified block diagram that includes the proportional controller. Hence, derive the new closed-loop transfer function and evaluate the resultant settling time T_S and steady-state error (e_{ss}) for a unit step input. (07 Marks)
 - (c) Given that the steady-state error did not converge to zero in part (b), identify and explain the modifications required to achieve a zero steady-state error and further enhance the overall system response. Justify your proposed changes with appropriate theoretical principles and practical considerations. (03 Marks)

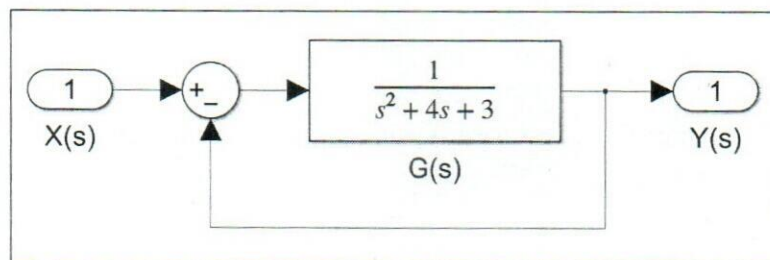


Figure 2: Closed-loop block diagram of the RCL low-pass filter.

Q3 (25 Marks)

- (i) Discuss the significance of frequency domain analysis in control system design and evaluation. In your answer, explain how frequency response methods provide insight into the behavior of dynamic systems and highlight why frequency-based techniques (such as Bode plots) are preferred in certain practical scenarios over time-domain methods. (03 Marks)
- (ii) Explain the role of gain compensation in frequency response design. In your answer, describe how adjusting the system gain can influence key frequency response characteristics such as the gain margin, and phase margin. (03 Marks)
- (iii) You are tasked with designing a gain compensator for an industrial system containing a motor and a load. The block diagram of the system is shown in Figure 3.
 - (a) Assuming the gain K has an initial value of 1, determine the open-loop transfer function of the system and obtain the expressions for magnitude and phase in frequency domain for this uncompensated system. (02 Marks)
 - (b) Using the frequency response obtained in part (a), plot the Bode diagram for the range of ω between 1 rads^{-1} and 100 rads^{-1} . (Use the provided log-linear sheet and attach it to the answer script.) (08 Marks)
 - (c) Determine the corresponding gain margin of the uncompensated system. (Clearly show your workings in the Bode diagram.) (03 Marks)
 - (d) Using the answers obtained in parts (b) and (c), design a gain compensator by determining the value of the gain " K " required to yield a 9.5% percentage overshoot in the transient response for a step input. (Assume a phase margin of 89.9 deg) (06 Marks)

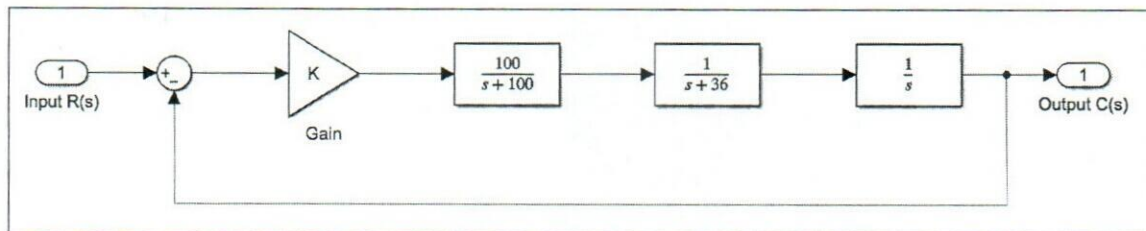


Figure 3: Block diagram of the system containing a motor and a load.

Q4 (25 Marks)

- (i) Microcontroller-based systems often integrate digital control with analog sensors and actuators. This introduces compatibility challenges. Describe two of these challenges and their corresponding corrective mechanisms. Utilize a block diagram to illustrate the description. (03 Marks)
- (ii) An analog controller is described by the transfer function provided in Equation 2. The design team has chosen to implement this controller digitally with an initial sampling period of 0.5 seconds.

$$G(s) = \frac{1}{0.5s + 1} \quad (2)$$

- (a) Apply the Tustin transformation and obtain the equivalent Z-transfer function of the digital controller. (04 Marks)
- (b) Express the Z-transfer function obtained in part (a) as a differential equation. (03 Marks)
- (c) Plot the unit step response of the digital controller for a period of $0 \leq t \leq 3$ seconds. (06 Marks)
- (d) Determine the output equation $y(t)$ of the analogue controller for a unit step input. (03 Marks)
- (e) Using the output equation obtained in part (d), plot the unit step response of the original analogue controller $G(s)$ for $0 \leq t \leq 3$ seconds. (06 Marks)

Annex I - Reference Equations

$$F_s = kx(t) \quad ; \quad F_d = \dot{x}(t)$$

$$G(s) = \frac{Y(s)}{X(s)} = \frac{k_{ss}\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

$$T_R = \frac{1.8}{\omega_n} \quad ; \quad T_S = \frac{4}{\zeta\omega_n} \quad ; \quad T_P = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} \quad ; \quad \%OS = e^{-\left(\frac{\zeta\pi}{\sqrt{1-\zeta^2}}\right)} \times 100 \quad ; \quad \cos(\theta) = \zeta$$

$$CLTF = \frac{G(s)}{1+G(s)} \quad ; \quad E(s) = \frac{R(s)}{1+G(s)} \quad ; \quad e_{ss} = \lim(s \rightarrow 0) s \cdot E(s)$$

$$PM = \Theta + 180 \quad ; \quad GM = 0 - x \quad ; \quad \zeta = \frac{-\ln\left(\frac{\%OS}{100}\right)}{\sqrt{\pi^2 + \ln^2\left(\frac{\%OS}{100}\right)}} \quad ; \quad \Theta_M = \tan^{-1}\left(\frac{2\zeta}{\sqrt{-2\zeta^2 + \sqrt{1+4\zeta^4}}}\right)$$

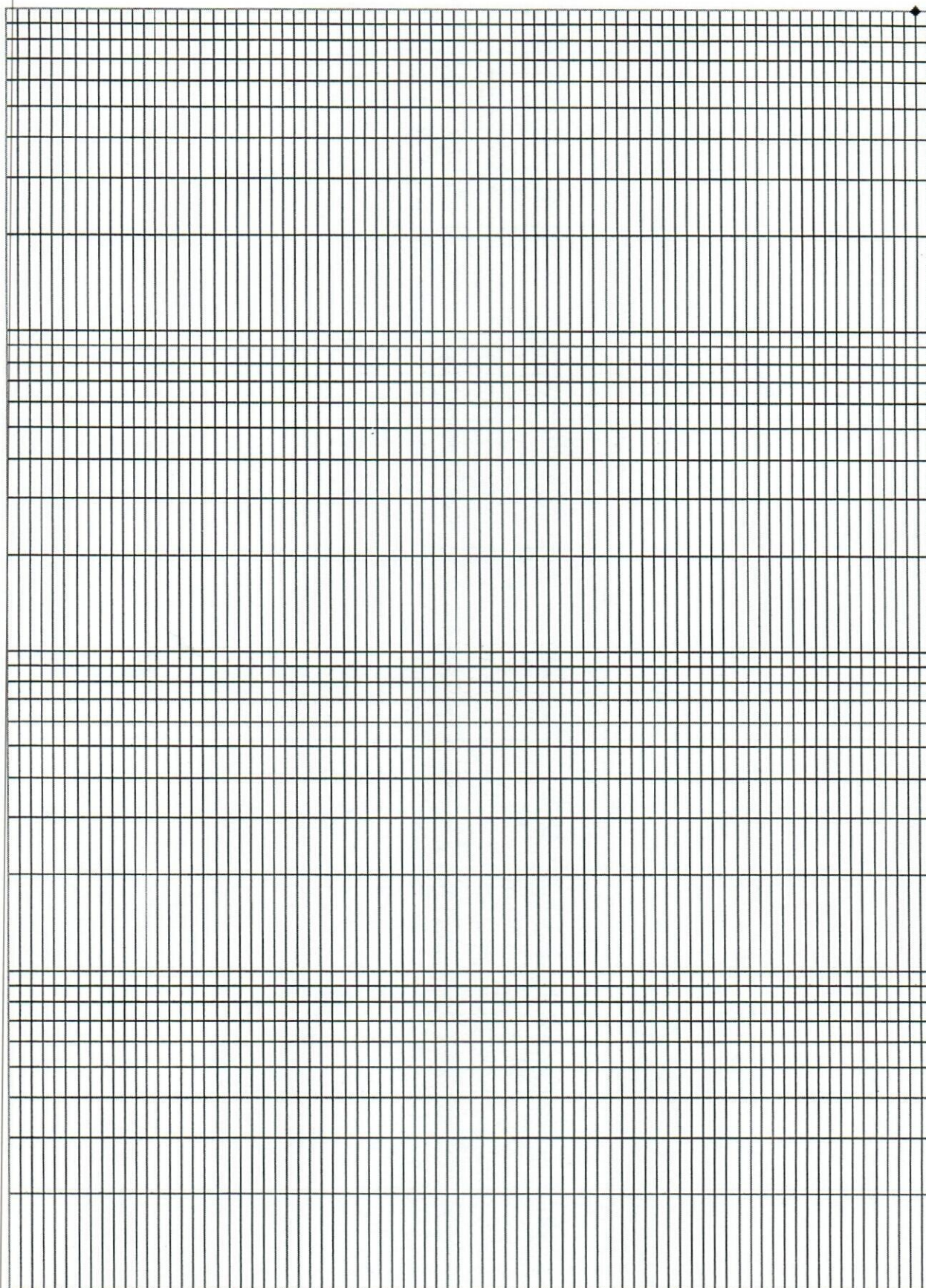
$$20 * \log(K) = Gain$$

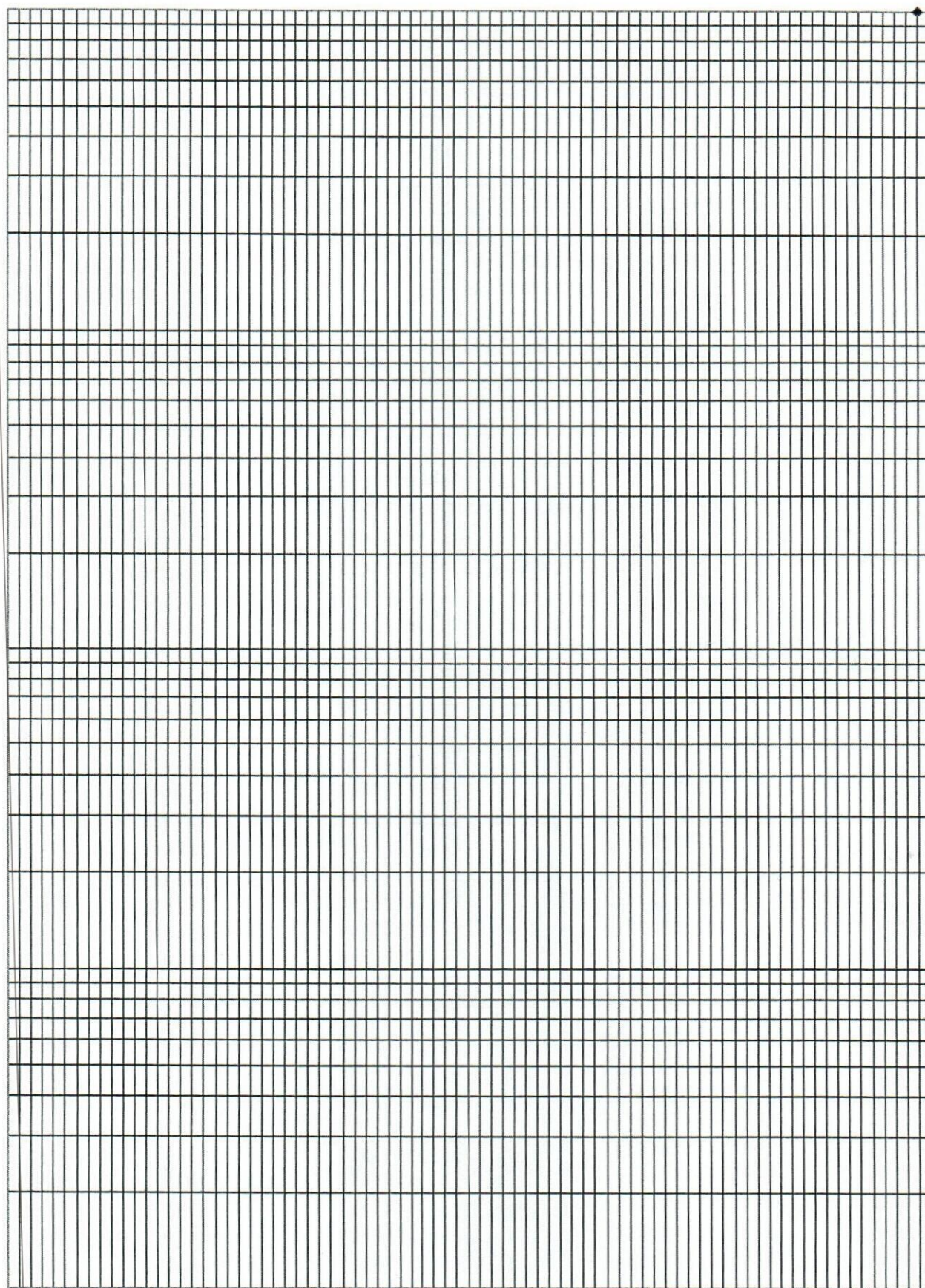
$$s = \frac{2z-1}{Tz+1}$$

Laplace Transform Pairs;

$$\begin{aligned} 1 &\leftrightarrow \frac{1}{s} \\ 1 - e^{-\alpha t} &\leftrightarrow \frac{\alpha}{s(s+\alpha)} \end{aligned}$$

-END OF EXAMINATION PAPER-







CINEC Campus
Faculty of Engineering and Technology
Department of Electrical and Electronics Engineering
**BSc Hons (Eng) Automotive/ Civil/ Electronic and Telecommunication/
Mechanical/ Mechatronic Engineering**
Batch 06 Semester 02 Re-Sit Examination 2025

Module Code : EE1325
Module Title : Programming Fundamentals
Date : 2nd April 2025
Examiners : Dushani Munasinghe
Time Allowed : 9.00AM – 12.00PM; 03hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 05 essay type questions. You should answer **ALL** questions.
- Write clearly legibly with a blue or black pen.
- Use only the **CINEC Answering Booklet**. Additional sheets may be requested from the invigilators.
- This paper consists of 04 pages.
- This examination is **programming language independent**. But the student should use **one language of choice** throughout the answer script.

MATERIALS REQUIRED

- CINEC answering booklet; Extra answering paper.
- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.

Question 01

- (i) Clearly explain what a programming language is, emphasizing the difference between high-level and low-level languages. Provide one example for each type. (04 Marks)
- (ii) Write a program to input two numbers as a keyboard inputs and calculate their sum and product, displaying both results clearly. (04 Marks)
- (iii) Draw a detailed flowchart to input a number, then clearly indicate whether the number is positive, negative, or zero. (06 Marks)
- (iv) Determine the output of the following program snippet, clearly explaining each step of your reasoning:

```
count = 10
count = count / 2
count = count + 7
print(count)
```

(06 Marks)

[Total - 20 Marks]

Question 02

- (i) What are '*conditional statements*' in programming languages? Explain their significance. (04 Marks)
- (ii) Write a program to input three numbers as keyboard inputs and to find the smallest out of the three to be displayed as the output. (06 Marks)
- (iii) Explain the difference between *while* and *do-while* loops using an example. (04 Marks)
- (iv) Write a program that prints the following pattern:

```
#
##
###
####
```

(06 Marks)

[Total - 20 Marks]

Question 03

- (i) Briefly explain two advantages of using functions in a computer program. Provide clear examples to support your explanation.

(04 Marks)

- (ii) Write a simple program that defines and calls a function named `displayWelcome()` to display the following message exactly as shown:

```
Welcome to Programming Fundamentals!  
Enjoy coding!
```

(04 Marks)

- (iii) Explain the purpose of creating arrays in computer programs.

(04 Marks)

- (iv) Write a program to define an array that stores five numbers: 10, 15, 20, 25, 30. The program should calculate and display the sum of these numbers as,

```
Sum of array elements: 100
```

(08 Marks)

[Total - 20 Marks]

Question 04

- (i) Briefly explain the use of pointers in programming.

(04 Marks)

- (ii) Write a simple program following the steps below:

- Declare two integer variables and assign the values 15 and 25 respectively.
- Declare two pointers and assign each pointer to above integer variables.
- Using pointers, calculate and display the sum of the two integer variables.

(07 Marks)

- (iii) Explain the functionality of three file handling classes: *ofstream*, *ifstream* and *fstream*.

(03 Marks)

- (iv) Write a program to obtain a student's name and age from the user, and write these details into a file named '*Student.txt*'. Clearly include steps for opening, writing, and closing the file.

(06 Marks)

[Total - 20 Marks]

Question 05

- (i) Clearly explain what is meant by an *exception* in programming and provide two practical examples of exceptions that could occur in a program. (04 Marks)
- (ii) In exception handling, the keywords *try*, *catch*, and *throw* play important roles. Clearly explain the purpose of each of these keywords. (03 Marks)
- (iii) Explain three (03) specific good programming practices that contribute to writing efficient and maintainable code. (06 Marks)
- (iv) Write a clear, organized, and fully-commented program that accomplishes the following:
- Prompts the user to input two numbers.
 - Calculates and displays the average of two numbers.

Your program must explicitly demonstrate good programming practices including:

- Clear and consistent indentation.
- Meaningful and descriptive variable names.
- Comprehensive comments explaining each significant step.

Sample Output:

```
Enter first number: 12
Enter second number: 8
Average of numbers: 10
```

(07 Marks)

[Total - 20 Marks]

-END OF EXAMINATION PAPER-



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Automotive Engineering/ Civil Engineering/
Electronic and Telecommunication Engineering/ Mechanical
Engineering/ Mechatronic Engineering
Batch 6 Semester 2 Resit Final Examination 2025

Module Code	:	EE1326
Module Title	:	Electronics
Date	:	31 st March 2025
Examiners	:	Srimal Punchihewa
Time Allowed	:	0900-1200; 3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of five (05) questions. You Should Answer **ALL** questions.
- Write clearly legibly with a blue or black pen.
- Use only the **CINEC Answering Booklet**. Additional sheets may be requested from the invigilators.
- This paper contains five (05) pages.

MATERIALS REQUIRED

- CINEC answering Booklet, Extra answering paper.
- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.

Q1.

- (a) Describe the difference between **n-type** and **p-type semiconductor materials**.

(4 marks)

- (b) Describe the two terms **donor atom** and **acceptor atom**.

(4 marks)

- (c) Define the term **extrinsic material**.

(4 marks)

- (d) Define the two terms **majority carriers** and **minority carriers**.

(4 marks)

- (e) Define the two terms **Energy level** and **Energy band**.

(4 marks)

(Total 20 marks)

Q2.

- (a) Draw sketches illustrating the ideal diode model and draw its V-I characteristics.

(3 marks)

- (b) Draw sketches illustrating the practical diode model for a Silicon diode and draw its V-I characteristics.

(3 marks)

- (c) Draw sketches illustrating the complete model for a Silicon diode and draw its V-I characteristics.

(4 marks)

- (d) Determine the forward voltage and forward current for the diode in figure 2.1 for each of the diode models. Also, find the voltage across the limiting resistor in each case. Assume $r'_d = 10 \Omega$ at the determined value of forward current.

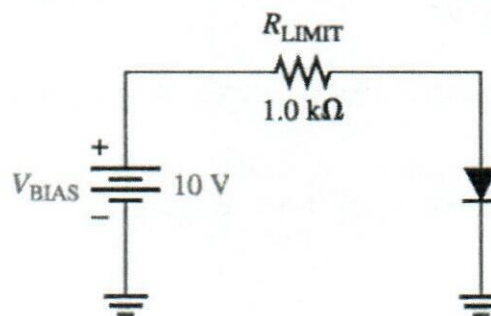


figure 2.1

(10 marks)
(Total 20 marks)

Q3.

- (a) Determine V_{CE} and I_C in the voltage-divider biased BJT circuit of figure 3.1 if $\beta_{DC} = 100$.

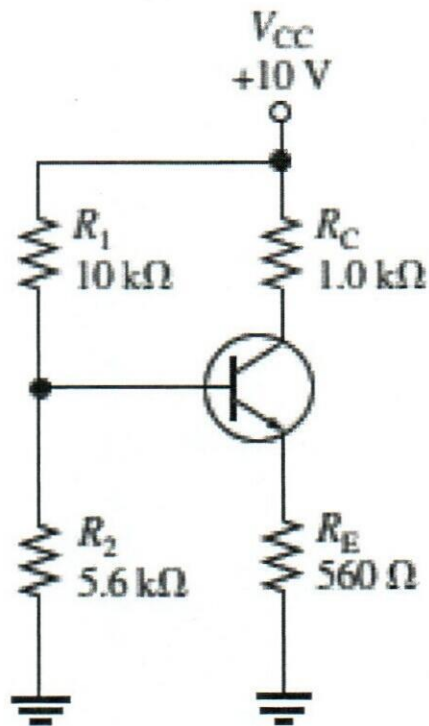


figure 3.1

(10 marks)

- (b) For a JFET, $I_{DSS} = 9 \text{ mA}$ and $V_{GS(off)} = -8 \text{ V}$.

Using these values, determine the drain current for $V_{GS} = 0 \text{ V}$, -1 V and -4 V .

(10 marks)

(Total 20 marks)

Q4.

- (a) The figure 4.1 shows an inverting op-amp circuit. (Op-Amp is ideal)
Calculate the gain V_{out}/V_{in} of the circuit. (show all the steps)

(4 marks)

If the input voltage V_{in} is 10V, calculate the output voltage V_{out} .

(4 marks)

If R_f is decreased in the figure 4.1, what changes will happen to the voltage gain?

(4 marks)

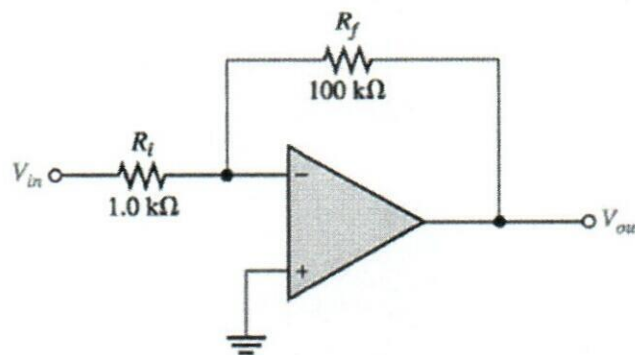


figure 4.1

- (b) For the circuit given in figure 4.2, calculate the value of R_f required to produce a gain of 50. (The op-amp is ideal)

(8 marks)

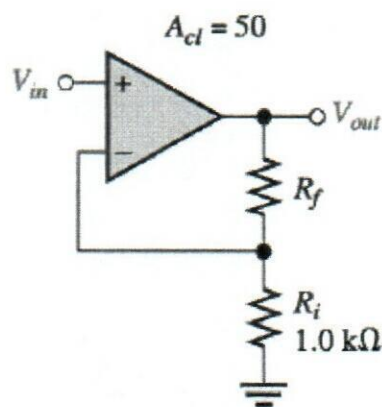


figure 4.2

(Total 20 marks)

Q5.

- (a) Write down the logic expression for the output Q shown in figure 5.1.

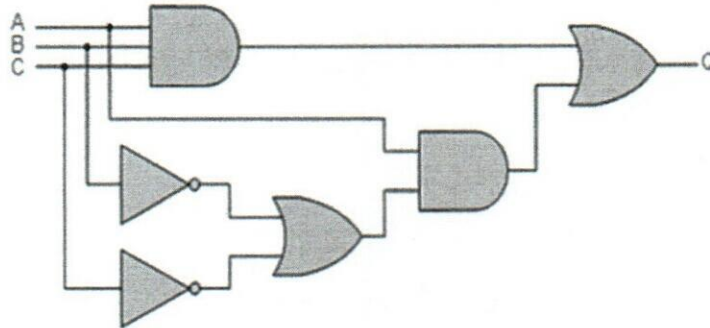


figure 5.1

(10 marks)

- (b) A three-variable logic function is given by $K_{(A,B,C)} = \sum(0,1,3,4,5)$.

Using Karnaugh maps find, minimum SOP expression

(5 marks)

- (c) Simplify the Boolean function $F = \bar{A}\bar{B}\bar{C} + AB\bar{C} + \bar{A}B\bar{C} + A\bar{C}\bar{B}$ using Karnaugh map.

(5 marks)

(Total 20 marks)

END OF EXAMINATION PAPER



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Batch 5 Year 2 Semester 4 Re-Sit Final Examination 2025

Module Code	:	EE2325
Module Title	:	Computer Organization
Date/Time	:	02 nd March 2025 / 1330-1630h
Examiners	:	Srimal Punchihewa
Time Allowed	:	3 Hours

INSTRUCTIONS TO CANDIDATES

- This is a Closed book examination.
- Answer **all the questions**.
- Each answer to be written in an answer booklet (provided).
- Each answer to start on a new page.
- This paper contains 3 pages

MATERIALS REQUIRED

- Answer booklets.
- You may use a scientific calculator. This must not be programmable. This may be examined.

Q1.

- (a) List the major components of a computer system. (3 Marks)
 - (b) List the major components of a processor (3 Marks)
 - (c) List the linkages of a computer to the external environment. (3 Marks)
 - (d) List the four categories of actions performed by the processor after interpreting the instruction. (3 Marks)
 - (e) State two basic categories of transfer mode and briefly describe. (4 Marks)
 - (f) Write brief notes on “first party” and “third party” DMA. (4 Marks)
- (Total 20 Marks)

Q2.

- (a) Write brief notes on varieties of peripherals and their capabilities. (5 Marks)
 - (b) State major requirements or functions of an I/O module. (5 Marks)
 - (c) Draw a generic model of an I/O module. (5 Marks)
 - (d) Draw an I/O module diagram. (5 Marks)
- (Total 20 Marks)

Q3.

- (a) State advantages of using glass as a substrate for magnetic disk. (5 Marks)
 - (b) Draw a sketch of “inductive write MR read” (5 Marks)
 - (c) Draw a diagram indicating disk layout methods of “constant angular velocity” and “multiple zoned velocity” (5 Marks)
 - (d) Write short notes on RAID 1 data protection method. (5 Marks)
- (Total 20 Marks)

Q4.

- (a) Draw a sketch of dynamic RAM structure and write short notes. (5 Marks)
 - (b) Write short notes on SRAM vs DRAM (5 Marks)
 - (c) Draw a model of control unit (5 Marks)
 - (d) List problems with hard wired designs of control unit (5 Marks}
- (Total 20 Marks)

Q5.

- (a) Draw the sketches of computer organizations of
 - (i) SISD
 - (ii) SIMD (with distributed memory)
 - (iii) MIMD (with shared memory)
 - (iv) MIMD (with distributed memory)(8 Marks)
 - (b) Draw a sketch of “symmetric multiprocessor organization” (6 Marks)
 - (c) List and briefly describe disadvantages of the bus organization. (6 Marks)
- (Total 20 Marks)

END OF EXAMINATION PAPER



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Year 2 Semester 3 First Sit Final Examination 2025

Module Code : **EE2316**
Module Title : **Signals and Systems**
Date/Time : **22nd February 2025 / 1330-1630h**
Examiners : **Srimal Punchihewa**
Time Allowed : **3 Hours**

INSTRUCTIONS TO CANDIDATES

- This is a Closed book examination.
- Answer **all the questions**.
- Each answer to be written in an answer booklet (provided).
- Each answer to start on a new page.
- This paper contains 9 pages

MATERIALS REQUIRED

- Answer booklets.
- You may use a scientific calculator. This must not be programmable. This may be examined.

Q1.

- (A) A continuous time signal $x(t)$ is shown in Fig 1.1. Sketch and label each of the following signals

- (a) $x(t - 2)$
(b) $x(-t)$

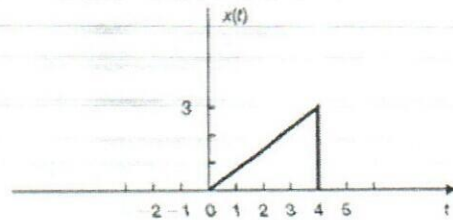


Fig 1.1

(3 Marks)

- (B) A discrete time signal $x[n]$ is shown in Fig 1.2. Sketch and label each of the following signals.

- (a) $x[n - 2]$
(b) $x[-n]$

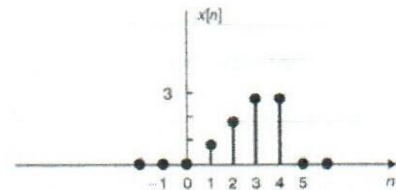


Fig 1.2

(3 Marks)

- (C) Sketch and label the even and odd components of the signals shown in Fig 1.3

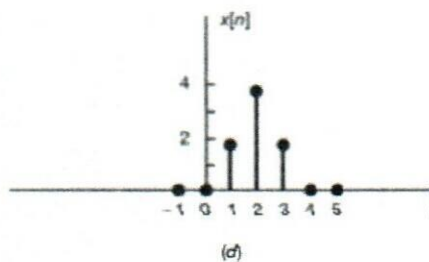
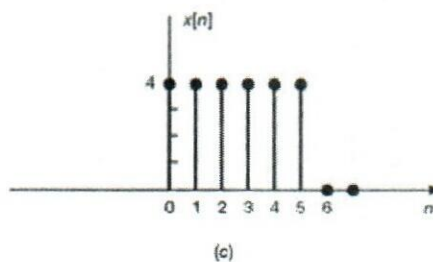
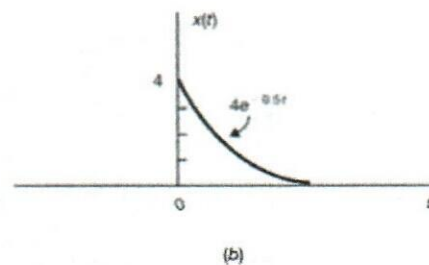
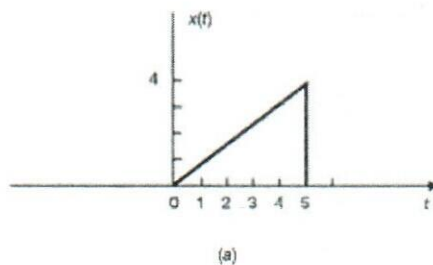


Fig 1.3

(4 Marks)

- (D) A system has the input-output relation given by $y[n] = \mathbf{T}\{x[n]\} = nx[n]$

Determine whether the system is

- (a) Causal (b) Linear (c) Time-invariant

(6 marks)

(Total 16 Marks)

Q2.

(A) Determine the complex exponential Fourier series representation for each of the following signals:

(a) $x(t) = \cos \omega_0 t$

(b) $x(t) = \sin \omega_0 t$

(10 Marks)

(B) Consider the periodic square wave $x(t)$ shown in Fig 2.1

Determine the complex exponential Fourier series of $x(t)$.

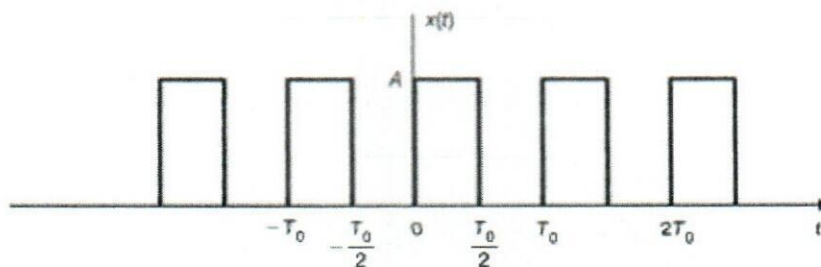


Fig 2.1

(10 Marks)
(Total Marks 20)

Q3.

(A) Find the Fourier Transform of the rectangular pulse signal $x(t)$ shown in Fig 3.1 defined by

$$x(t) = p_a(t) = \begin{cases} 1 & |t| < a \\ 0 & |t| > a \end{cases}$$

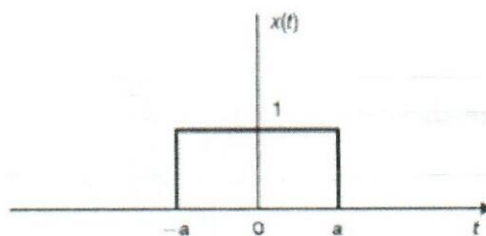


Fig 3.1

(6 Marks)

(B) Find the Fourier Transform of the signal shown in Fig 3.2 and defined by

$$x(t) = e^{-a|t|} \quad a > 0$$

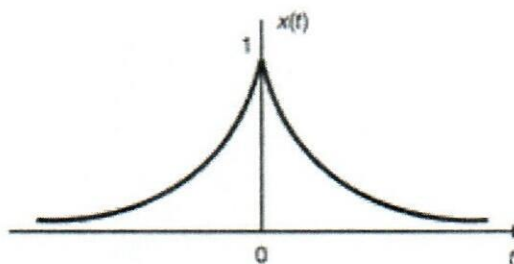


Fig 3.2

(6 Marks)

(Total Marks 12)

Q4.

(A) Determine the Fourier coefficients for the periodic sequence $x[n]$ shown in Fig 4.1

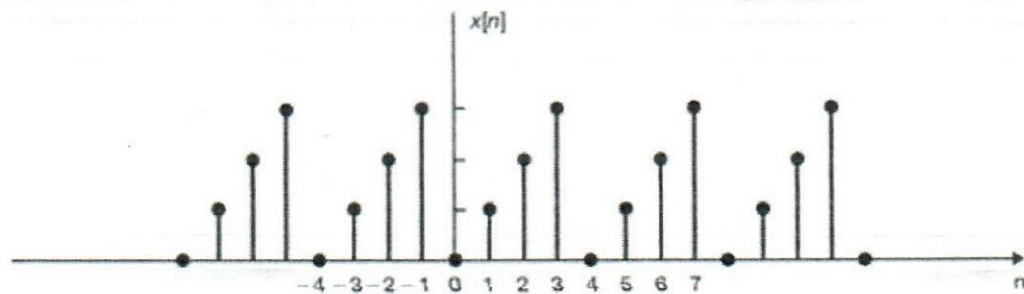


Fig 4.1

(5 Marks)

(B) Consider the periodic sequence $x[n]$ shown in Fig 4.2. Determine the Fourier coefficients c_k and sketch the magnitude spectrum $|c_k|$

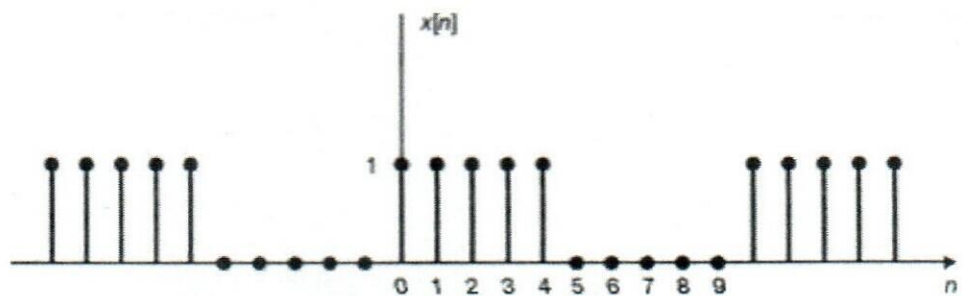


Fig 4.2

(7 Marks)

(Total Marks 12)

Q5.

- (A) Find the Laplace transform $X(s)$ and sketch the pole-zero plot with the ROC for the following signals $x(t)$:

$$x(t) = e^{-2t}u(t) + e^{-3t}u(t)$$

(10 Marks)

- (B) Find the inverse Laplace transform of

$$X(s) = \frac{5s + 13}{s(s^2 + 4s + 13)} \quad \text{Re}(s) > 0$$

(10 Marks)

(Total Marks 20)

Q6.

- (A) Find the z-transform $X(z)$ and sketch the pole-zero plot with the ROC for the following sequence:

$$x[n] = \left(\frac{1}{2}\right)^n u[n] + \left(\frac{1}{3}\right)^n u[n]$$

(10 Marks)

- (B) Using the partial fraction expansion, find the inverse z-transform of the following $X(z)$:

$$X(z) = \frac{z}{2z^2 - 3z + 1} \quad |z| < \frac{1}{2}$$

(10 Marks)

(Total Marks 20)

FORMULA SHEET

$$x(t) = \sum_{k=-\infty}^{\infty} c_k e^{jk\omega_0 t} \quad \omega_0 = \frac{2\pi}{T_0}$$

$$c_k = \frac{1}{T_0} \int_{T_0} x(t) e^{-jk\omega_0 t} dt$$

$$X(\omega) = \mathcal{F}\{x(t)\} = \int_{-\infty}^{\infty} x(t) e^{-j\omega t} dt$$

$$x(t) = \mathcal{F}^{-1}\{X(\omega)\} = \frac{1}{2\pi} \int_{-\infty}^{\infty} X(\omega) e^{j\omega t} d\omega$$

$$X(s) = \int_{-\infty}^{\infty} x(t) e^{-st} dt$$

$$X(z) = \sum_{n=-\infty}^{\infty} x[n] z^{-n}$$

$x(t)$	$X(s)$	ROC
$\delta(t)$	1	All s
$u(t)$	$\frac{1}{s}$	$\text{Re}(s) > 0$
$-u(-t)$	$\frac{1}{s}$	$\text{Re}(s) < 0$
$tu(t)$	$\frac{1}{s^2}$	$\text{Re}(s) > 0$
$t^k u(t)$	$\frac{k!}{s^{k+1}}$	$\text{Re}(s) > 0$
$e^{-at} u(t)$	$\frac{1}{s+a}$	$\text{Re}(s) > -\text{Re}(a)$
$-e^{-at} u(-t)$	$\frac{1}{s+a}$	$\text{Re}(s) < -\text{Re}(a)$
$te^{-at} u(t)$	$\frac{1}{(s+a)^2}$	$\text{Re}(s) > -\text{Re}(a)$
$-te^{-at} u(-t)$	$\frac{1}{(s+a)^2}$	$\text{Re}(s) < -\text{Re}(a)$
$\cos \omega_0 t u(t)$	$\frac{s}{s^2 + \omega_0^2}$	$\text{Re}(s) > 0$
$\sin \omega_0 t u(t)$	$\frac{\omega_0}{s^2 + \omega_0^2}$	$\text{Re}(s) > 0$
$e^{-at} \cos \omega_0 t u(t)$	$\frac{s+a}{(s+a)^2 + \omega_0^2}$	$\text{Re}(s) > -\text{Re}(a)$
$e^{-at} \sin \omega_0 t u(t)$	$\frac{\omega_0}{(s+a)^2 + \omega_0^2}$	$\text{Re}(s) > -\text{Re}(a)$

$x[n]$	$X(z)$	ROC
$\delta[n]$	1	All z
$u[n]$	$\frac{1}{1-z^{-1}}, \frac{z}{z-1}$	$ z > 1$
$-u[-n-1]$	$\frac{1}{1-z^{-1}}, \frac{z}{z-1}$	$ z < 1$
$\delta[n-m]$	z^{-m}	All z except 0 if $(m > 0)$ or ∞ if $(m < 0)$
$a^n u[n]$	$\frac{1}{1-az^{-1}}, \frac{z}{z-a}$	$ z > a $
$-a^n u[-n-1]$	$\frac{1}{1-az^{-1}}, \frac{z}{z-a}$	$ z < a $
$na^n u[n]$	$\frac{az^{-1}}{(1-az^{-1})^2}, \frac{az}{(z-a)^2}$	$ z > a $
$-na^n u[-n-1]$	$\frac{az^{-1}}{(1-az^{-1})^2}, \frac{az}{(z-a)^2}$	$ z < a $
$(n+1)a^n u[n]$	$\frac{1}{(1-az^{-1})^2}, \left[\frac{z}{z-a} \right]^2$	$ z > a $
$(\cos \Omega_0 n)u[n]$	$\frac{z^2 - (\cos \Omega_0)z}{z^2 - (2\cos \Omega_0)z + 1}$	$ z > 1$
$(\sin \Omega_0 n)u[n]$	$\frac{(\sin \Omega_0)z}{z^2 - (2\cos \Omega_0)z + 1}$	$ z > 1$
$(r^n \cos \Omega_0 n)u[n]$	$\frac{z^2 - (r \cos \Omega_0)z}{z^2 - (2r \cos \Omega_0)z + r^2}$	$ z > r$
$(r^n \sin \Omega_0 n)u[n]$	$\frac{(r \sin \Omega_0)z}{z^2 - (2r \cos \Omega_0)z + r^2}$	$ z > r$
$\begin{cases} a^n & 0 \leq n \leq N-1 \\ 0 & \text{otherwise} \end{cases}$	$\frac{1-a^N z^{-N}}{1-az^{-1}}$	$ z > 0$

END OF EXAMINATION PAPER



Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Electronics & Telecommunication Engineering
BSc Hons (Eng) Mechanical Engineering
BSc Hons (Eng) Automotive Engineering
Batch 06 Year 2 Semester 3 First Sit Final Examination 2025

Module Code	:	EE2315
Module Title	:	Digital Electronics
Date/Time	:	14 th February 2025/ 0900-1200h
Examiners	:	Srimal Punchihewa
Time Allowed	:	3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- You Should Attempt **ALL** questions.
- Show all the working on the answer paper.
- Each answer to be **handwritten on** answering booklet provided in black or blue ink.
- Present your answer to three decimal places.
- This paper contains 5 pages.

MATERIALS REQUIRED

- Answering Booklet
- Scientific Calculator (This must not be programmable and may be inspected during the examination).

1.

a. For the Boolean function $F(x, y, z) = xy'z + x'y + x'z + yz$,

(i) Draw the Truth Table and using that express the function as a sum of minterms

(8 Marks)

(ii) Draw the Karnaugh Map and using that find the minimal sum-of-products expression.

(5 Marks)

b. Simplify each of the Boolean functions F together with don't care conditions in sum of products form.

(i) $F(w, x, y, z) = \sum(0, 1, 2, 3, 7, 8, 10)$, $d(w, x, y, z) = \sum(5, 6, 11, 15)$

(6 Marks)

(ii) $F(w, x, y, z) = \sum(4, 12, 7, 2, 10)$, $d(w, x, y, z) = \sum(0, 6, 8)$

(6 Marks)

(Total 25 marks)

2.

a. The truth table of a BCD to Excess-3 code converter is shown in Fig 2.1

Input BCD				Output Excess-3 Code			
A	B	C	D	w	x	y	z
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0

Fig 2.1

- (i) Draw the Karnaugh Maps for each of the four outputs. (5 Marks)
- (ii) Indicate the don't care conditions also in the maps. (2 Marks)
- (iii) Write logic expressions for each of the four outputs. (2 Marks)
- b. (i) Draw the block diagram of a full adder and draw its truth table. (3 Marks)
- (ii) Draw the Karnaugh Maps for each of the outputs of the full adder. (3 Marks)
- (iii) Write logic expressions for each of the outputs in sum-of-products form (2 Marks).
- c. Two four-bit numbers $A_3A_2A_1A_0$ and $B_3B_2B_1B_0$ are required to be added.
- (i) Draw the logic diagram to implement the above using four full adders. (5 Marks)
- (ii) Briefly discuss the carry propagation problem in the above adder in 2.c. (i). (3 Marks)
- (Total Marks 25)

3.

- a. It is required to multiply two binary numbers B_1B_0 and A_1A_0

Draw the logic diagram to gate implement the two-bit-by-two-bit binary multiplier to implement the above multiplication

(8 Marks)

b.

- (i) Draw a block diagram and briefly discuss the meaning of a decoder circuit in combinational logic

(2 Marks)

- (ii) Draw the truth table of a three-to-eight-line decoder

(4 Marks)

- (iii) Draw a logic diagram to implement a three-to-eight-line decoder.

(3 Marks)

c.

- (i) Draw a block diagram of a two-to-one-line multiplexer and briefly explain the same.

(3 Marks)

- (ii) Draw a logic diagram to gate implement the two-to-one-line multiplexer

(5 Marks)

(Total 25 Marks)

4.

a.

- (i) Draw the truth table of a RS latch. (3 Marks)
 - (ii) Draw a logic diagram using NOR gates to implement a RS latch. (3 Marks)
 - (iii) Draw the State Transition Table and State diagram for RS latch. (6 Marks)
 - (iv) Draw the truth table for a JK Flip-flop (3 Marks)
 - (v) A Traffic Light Problem is to be implemented using D type Flip-flops. The sequence of Traffic lights is Red, Red+Amber, Green, Amber and then Red again and so on. Draw
 - a. State Transition Diagram (3 Marks)
 - b. State Transition Table (3 Marks)
 - c. By drawing Karnaugh Maps along with unused states or otherwise, find logic expressions for D_R , D_A and D_G (4 Marks)
- (Total 25 Marks)

END OF THE EXAMINATION PAPER



Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Electronics & Telecommunication Engineering
Year 3 Semester 5 First Sit Final Examination 2025

Module Code	:	EE3312
Module Title	:	Communication II
Date/Time	:	5 th February 2025/ 01.30 pm – 04.30 pm
Examiners	:	Srimal Punchihewa
Time Allowed	:	3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- You Should Attempt **ALL** questions.
- Show all the working on the answer paper.
- Each answer to be **handwritten on** answering booklet provided in black or blue ink.
- Present your answer to numerical questions up to three decimal places.
- This paper contains 5 pages.

MATERIALS REQUIRED

- Answering Booklet
- Scientific Calculator (This must not be programmable and may be inspected during the examination).

1. FSK (Frequency-Shift Keying) is a modulation technique where data is represented by changing the frequency of a carrier wave, while Manchester coding is a specific method of encoding digital data where each bit is represented by a transition between high and low voltage levels, essentially embedding the clock signal within the data itself, making it useful for reliable data recovery in noisy environments; often used in conjunction with other modulation schemes like FSK to improve data integrity.

FSK is used in the old 300 baud modem. A "300 baud modem" refers to an old-style modem that operates at a speed of 300 baud, which was a very slow data transmission rate considered standard in early personal computers.

This modem used Manchester signaling. Manchester pulse consists of two "half" pulses. The duration of one bit in these modems was 1.6667 ms. The frequency used to represent one of the half pulses was 1.5 kHz and the frequency used to represent the other half pulse was 1.8 kHz.

- i) Write a short summary on "FSK" modulation technique including an illustration, and/or a mathematical expression.

(4 marks)

- ii) What is "BPSK"?

(4 marks)

- iii) Explain the time domain and frequency domain representations of FSK with the use of appropriate diagrams.

(6 marks)

- iv) Determine the frequency deviation of the above mentioned 300 baud modems using the given information.

(6 marks)

- v) Calculate the minimum bandwidth of the 300 baud modem.

(5 marks)

(Total Marks 25)

2. An experiment conducted to measure sensitivity to a weak signal would typically involve presenting a participant with a series of stimuli, where some trials contain a very faint signal mixed with background noise, and others only contain noise, and then asking the participant to identify when they detect the signal, allowing researchers to assess their ability to distinguish the signal from the background noise. Such an experiment is conducted that measures sensitivity to a weak signal. On each trial the signal is either present (signal trials) or absent (noise trials), and the subject must respond "present" or "absent". The probability of a signal being presented on any given trial is 0.5. The data obtained from a signal detection experiment is depicted in the table below.

Table 1: Experiment Data

Transmitter	Responses (Receiver)	
Stimulus	Present	Absent
Signal	80	20
Noise (No signal)	20	80

- i) Define the possible hypothesis for the above scenario. (4 marks)
 - ii) What is the prior probability of signal? (4 marks)
 - iii) Explain the detection theory concept using above scenario. (5 marks)
 - iv) What is AWGN stands for? Write a summary to explain AWGN. (6 marks)
 - v) Explain the operation and the requirement of Optimal Receiver for a AWGN channel. (6 marks)
- (Total Marks 25)

3. Multi-carrier modulation (MCM), particularly in the form of Orthogonal Frequency Division Multiplexing (OFDM), finds applications in a wide range of communication systems, including: digital subscriber lines (DSL), wireless local area networks (WLANs), digital audio broadcasting (DAB), digital video broadcasting (DVB), powerline communication, and modern mobile communication standards like 4G LTE and 5G due to its ability to efficiently transmit large amounts of data over channels with significant frequency selective fading, offering high spectral efficiency and robustness to interference.

i. Write a brief description for multi carrier modulation?

(5 marks)

ii. State the advantages of multi carrier modulation.

(3 marks)

iii. In multi-carrier modulation, as individual subcarriers are overlapping, isn't there any interference between carriers?

(5 marks)

iv. Describe the operation of OFDM modulation technique using a diagram.

(7 marks)

v. Compare the pros and cons of OFDM modulation technique.

(5 marks)

(Total Marks 25)

4. Spread spectrum is a radio frequency (RF) communication technique that spreads data over a wide range of frequencies. It's used to make transmissions more secure, reduce interference, and improve bandwidth sharing.
- i. Describe the operation of spread spectrum system using a diagram.
(7 marks)
 - ii. Explain the Frequency Hopping Spread Spectrum (FHSS) operation.
(6 marks)
 - iii. Draw a diagram for FHSS transceiver model and explain the operation.
(6 marks)
 - iv. Draw a diagram for Direct Sequence Spread Spectrum (DSSS) transceiver model and explain the operation.
(6 marks)
- (Total Marks 25)

END OF THE EXAMINATION PAPER