



PAST PAPERS

Faculty	Department / Section/Division
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Past Papers

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EE4316

Final Examination

Image Processing and Machine Vision



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc Hons (Eng) Mechatronic Engineering
Semester 7 First Sit Final Examination 2024

Module Code	:	EE4316
Module Title	:	Image Processing and Machine Vision
Date	:	07/12/2024
Examiners	:	Mr. Ashan Weeraratne
Time Allowed	:	3 Hours

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 25 MCQ and 3 Essay questions. You should answer all questions.
- Write clearly and legibly with a blue or black pen.
- Use only the **CINEC Answering Booklet**. Additional sheets may be requested from the invigilators.
- This paper contains 10 pages.

MATERIALS REQUIRED

- CINEC answering Booklet; Extra answering paper
- MCQ answer sheet (Annex I)
- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.

Section I: Multiple Choice Questions [25 marks]

1. What is the purpose of the Bayer filter in image sensors?
 - a. To adjust image brightness
 - b. To allow electro-magnetic waves only of certain colour to pass through
 - c. To convert light to electrical signals
 - d. To prevent electro-magnetic waves in the infra-red region from reaching the sensor
2. What is the purpose of demosaicing in image sensors?
 - a. To reduce noise in images
 - b. To construct [R,G,B] vector for a single pixel from 4 sensor readings
 - c. To increase signal-to-noise ratio in images
 - d. To remove signals caused by waves in the non-visible regions
3. Which one of the following image formats has lossless compression & lossy compression with no transparency channel respectively?
 - a. GIF, PNG
 - b. PNG, GIF
 - c. PNG, JPEG
 - d. GIF, JPEG
4. Which one of the following statements about CCD & CMOS sensors, is wrong?
 - a. CCD chips are arrays of capacitors and CMOS sensors are arrays of photo-diodes
 - b. CMOS sensors have a faster readout compared to CCD ones
 - c. CMOS sensors are cheaper compared to CCD ones
 - d. CMOS sensors have a higher image quality compared to CCD ones
5. Which type of lens would be appropriate for a security system looking at a target 1km away from the camera?
 - a. Super-Telephoto
 - b. Fisheye
 - c. Wide-Angle
 - d. Standard
6. Which of the following is not an interface for digital cameras?
 - a. Gigabit Ethernet
 - b. I2C
 - c. Camera Digital Interface
 - d. Camera Link
7. Which one of the following is not an abbreviation for a color space?
 - a. RGB
 - b. CMYK
 - c. L*ab
 - d. HSK

8. In adaptive thresholding, the threshold value for a pixel is determined based on?
- Fixed value specified manually
 - Intensity of the surrounding region
 - Intensity of the whole image
 - Signal to noise ratio of the camera
9. Which of the following is not a task which can be accomplished using filters?
- Edge extraction
 - Rotating image
 - Adding Gaussian noise
 - Removing Gaussian noise
10. Which of the following is not an objective of the convolution operation?
- Increasing or decreasing sharpness
 - Making colour adjustments
 - Evaluating the degree of similarity of region to a template
 - Adding geometric distortions
11. Which one of the following explains how the Canny algorithm improves the Sobel edge detector?
- Preventing false negatives by evaluating connectivity to confirmed positives
 - Using the mean of the surrounding area as the threshold value
 - Removing false positives based on the intensity distribution
 - Preventing false positives by evaluating similarity to confirmed negatives
12. Which morphological operation is used to remove pepper noise & salt noise respectively without imparting severe size distortions?
- Opening, Closing
 - Erosion, Dilation
 - Dilation, Erosion
 - Closing, Opening
13. Which of the following is not an application which can be solved using Fiducial Markers?
- Vision guided autonomous landing of a quadcopter
 - Visually tracking a swarm of ground robots from a base station
 - Estimating the pose of barely visible vehicles for autonomous driving
 - Estimating the pose of the vehicle in front for autonomous driving
14. Which of the following is not a fiducial marker
- AR Tag
 - Bar Code
 - April Tag
 - ARUCO marker

15. Which one of the following is not a DNN for estimating the distance to objects in images?
- a. SAM by Meta
 - b. ZoeDepth by ETH Zurich
 - c. MiDaS by Intel
 - d. Depth Anything by TikTok
16. Which one of the following is not a DNN built for semantic segmentation of objects in images?
- a. Segment Anything Model
 - b. FastSAM by IVA Lab
 - c. YOLOv8n
 - d. YOLOv8n-seg
17. Which one of the following is not an online repository of pre-trained neural networks pertaining to machine vision?
- a. Kaggle Models
 - b. Mediapipe Library
 - c. Anthropic
 - d. Hugging Face
18. Which of the following has a repository of annotated datasets?
- a. Kaggle
 - b. Keras Models
 - c. Roboflow Universe
 - d. Hugging Face
19. Which of the following is not an image annotation aid found on Roboflow?
- a. Box Prompting
 - b. Label Assist
 - c. Segment Assist
 - d. Smart Polygon
20. Which one of the following is not a cloud-based platform that can be used for training neural networks?
- a. Google Colab
 - b. Ultralytics Hub
 - c. Mediapipe
 - d. Roboflow
21. Which one of the following is not a cloud-based platform which can be used to host a permanent API for running inferences on images?
- a. Google Colab
 - b. Ultralytics Hub
 - c. TensorFlow Serving
 - d. Roboflow
22. For how long can an individual notebook run, on the free tier of the Google Cloud environment?
- a. 72 hours
 - b. 12 hours
 - c. 100 hours
 - d. No such time limit

23. Which one of the following is not a processing hardware platform provided in Google Colab?

- a. NVIDIA H100 GPU
- b. NVIDIA T4 GPU
- c. NVIDIA V100 GPU
- d. Google Cloud TPU v2

24. Which one of the following is not a multi-modal large language model?

- a. GPT-4o
- b. Claude 3 Opus
- c. Gemma2 2B
- d. Gemini 1.5 Pro

25. Which of the following is not an application which can be performed using currently available multi-modal large language models?

- a. Reading text & numbers in images
- b. Calibrating a camera
- c. Counting objects of interest in an image
- d. Provide bounding boxes for an object of interest

Section II – Essay Questions

Question 1 [25 marks]

- a) State the purposes of the following layer types in neural networks (4 marks)
 - a. Convolutional layer
 - b. Activation layer
 - c. Pooling layer
 - d. Softmax layer
- b) State one (1) pre-trained neural network for each of the following machine vision tasks (4 marks)
 - a. Image Classification
 - b. Object Detection
 - c. Instance Segmentation
 - d. Keypoint Detection
- c) Describe the key benefit of transfer learning. (2 marks)
- d) State the key steps of transfer learning in correct order, in the context of detection of a new set of classes (2 marks)
- e) The curve in Fig (A). was obtained during the training process. Identify the issue. State the cause of the issue and the necessary course of action to rectify the issue. (3 marks)

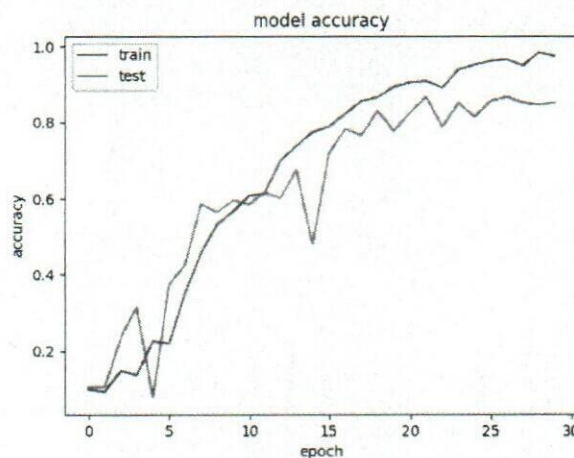


Fig (A).

- f) The confusion matrix given in Fig (B). Is for a transfer learning task done to train a model to detect different alert signs. Develop binary confusion matrices for the alert classes: Green & Crisis.

(4 marks)

True label	Green	166	40	3	6
	Amber	55	26	10	3
	Red	11	13	15	9
	Crisis	14	15	8	5
		Green	Amber	Red	Crisis

Fig (B).

- g) Evaluate the following performance metrics

(6 marks)

- Accuracy
- Precision
- Recall

Question 2 [25 marks]

- a) State two types of information that can be extracted from ARUCO markers. (2 marks)
- b) Identify the applications of ARUCO markers depicted in Figs B).1-3. (3 marks)



Fig B).1



Fig B).2



Fig B).3

- c) Some students have proposed using the marker given in Fig C).2 and template matching to measure the vibration frequency of a machine that vibrates in 1 degree of freedom. A simplified kinematic model of the machine is depicted in Fig C).1. Describe the algorithm they have to implement in order to measure the vibration frequency. Use flowcharts or pseudo code to describe the algorithm. (8 marks)

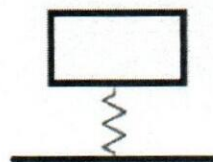


Fig C).1

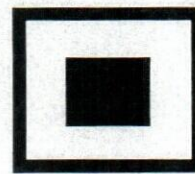


Fig C).2

- d) Explain whether non-maximum suppression will be required in the algorithm mentioned above. (3 marks)
- e) The students also want to measure the vibration frequency of a machine which vibrates in 2 degrees of freedom. A simplified kinematic model of the machine is depicted in Fig D. Explain why the marker in Fig C).2 will not be sufficient for this task. (3 marks)

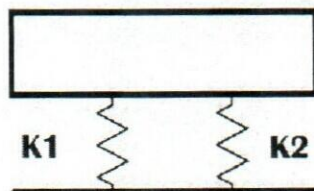


Fig D).

- f) Sketch a suitable marker which overcomes the deficiency identified in question 2.(d).

(2 marks)

- g) It was found that the performance of the template matching algorithm is insufficient. Describe an algorithmic improvement that can be made to obtain significant performance gains.

(4 marks)

Question 3 [25 marks]

- a) Describe what the following terms mean (4 marks)
- a. Instance Segmentation
 - b. Semantic Segmentation
 - c. Depth Estimation
 - d. Keypoint Estimation
- b) Describe how data is annotated during transfer learning for the following 2 cases (2 marks)
- a. Instance Segmentation
 - b. Depth Estimation
- c) Describe how instance segmentation is used as an aid for annotating datasets for detection tasks. (2 marks)
- d) Describe what is meant by Zero-shot classification, and its key advantage over traditional classifiers. (3 marks)
- e) State 3 examples of open-source neural network models which can be used for zero-shot classification. (2 marks)
- f) Describe the process of developing a custom machine vision workflow and serving it as a cloud-hosted API using Roboflow. (3 marks)
- g) Describe how a program running on a computing device calls a Roboflow inference endpoint. (4 marks)
- h) State what is meant by edge inferencing, and why it is sought after than cloud-hosted API endpoints (2 marks)
- i) State 3 hardware platforms which can be used for edge inferencing, and provide a brief description for each. (3 marks)

ANNEX I - MCQ ANSWER SHEET

Student ID:.....

Instructions - 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)
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23. (A) (B) (C) (D)
24. (A) (B) (C) (D)
25. (A) (B) (C) (D)



CINEC Campus
Faculty of Engineering and Technology
Department of Electrical and Electronic Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Semester 07 First-Sit Examination 2024

Module Code : EE4314
Module Title : Communication III
Date : 07th December 2024
Examiners : Ms. Dushani Munasinghe
Time Allowed : 9.00 AM – 12.00 PM; 03hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of four (04) 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 06 pages.
- A formula sheet is appended at the end of the question paper.

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

- (a) Binary data is transmitted as a sequence of pulses $p(t)$ and when these pulses are transmitted through a band-limited channel, the restricted frequency components cause time-domain spreading leading to **Inter Symbol Interference (ISI)**.
- (i) Explain how the frequency components of a rectangular pulse with width T_s are distributed in the frequency domain using proper illustrations. Use this to analyze why such a pulse shape causes significant *ISI* in a band-limited channel with a bandwidth of BHz .
(05 Marks)
- (ii) State the necessary and sufficient condition for Nyquist's first criterion for zero *ISI* and propose a pulse shape that satisfies the Nyquist's criterion using suitable illustrations.
(05 Marks)
- (b) Nyquist's criterion for controlled *ISI* can be used to simplify the detection in communication systems. Duobinary signalling is one of the methods that uses controlled ISI with precoding to aid **symbol-by-symbol detection**.
- (i) Analyze the pulse shape of duobinary pulse to achieve controlled *ISI*. (*Use necessary illustrations in your explanation*)
(05 Marks)
- (ii) For a binary data sequence of 1111001001110101, determine the pre-coded sequence (p_k), transmitted sequence (a_k), received sequence (b_k) and the detected sequence (d_k).
(04 Marks)
- (c) Data at a rate of $6kbit/s$ is to be transmitted over a leased line of bandwidth $4kHz$ by using Nyquist criterion pulses. Determine the maximum value of the roll-off factor r that can be used.
(06 Marks)

[Total - 25 Marks]

Question 02

- (a) Channel equalizers are used to reversal the distortion incurred by the channel during transmission.
- Explain the concept of channel equalization and its importance in eliminating distortion in digital communication systems.
(05 Marks)
 - Discuss the operation of **Zero Forcing Equalizers (ZFE)** to mitigate *ISI*. (Consider a three tap ZFE to explain your answer.)
(05 Marks)
- (b) A communication system transmits a pulse $p(t)$ through a linear time-invariant channel, resulting in the received samples of the pulse $p[k]$ at discrete time intervals. The samples received are: $P[-2] = 0.1, P[-1] = 0.2, P[0] = 1.0, P[1] = 0.3, P[2] = 0.1$. Design a three tap equalizer ($N = 1$) by finding the equalizer tap settings denoted by C_{-1}, C_0, C_1 that reduce *ISI* so that the equalized pulse samples have the values, $z[-1] = 0, z[0] = 1, z[1] = 0$.
(10 Marks)

[Total - 20 Marks]

Question 03

- (a) Consider a discrete source that contains a set of messages, m_0, m_1, m_2, m_3, m_4 and m_5 with corresponding probabilities of occurrence, 0.01, 0.15, 0.34, 0.22, 0.08, 0.2.
- Generate a variable-length **Huffman code** for above message sequence.
(04 Marks)
 - Find the average length, (L), of the compact code in bits.
(04 Marks)
 - Calculate the entropy, $H(m)$, of the source in bits.
(04 Marks)
- (b) A **Binary Symmetric Channel (BSC)** with corresponding source probabilities are given in Figure 1. Calculate the channel capacity of the BSC using given information.

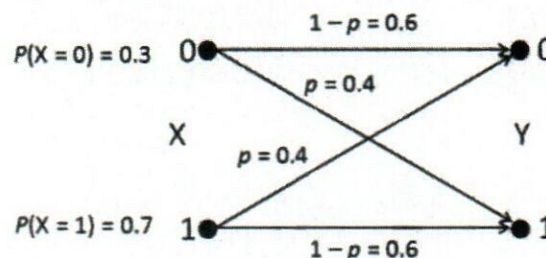


Figure 1: Binary Symmetric Channel (BSC)

(08 Marks)

[Total - 20 Marks]

Question 04

- (a) A cipher system performs **data encryption and decryption** to protect data from unauthorized access. Sketch and explain the block diagram of a cipher system in detail. (Use not more than two sentences for the description of each block.)

(10 Marks)

- (b) **Linear block codes** are a type of error-detection and error-correction coding technique used in digital communication systems. Find the parity check matrix, H , for the given generator matrix, G , for a $(6, 3)$ linear block code.

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$$

(06 Marks)

- (c) **Cyclic codes** are a type of linear block codes which has a cyclic property, defined by a generator polynomial, $g(x)$. Construct a systematic $(7, 4)$ cyclic code using a generator polynomial, $g(x) = x^3 + x^2 + 1$ for a data block of (1110)

(06 Marks)

- (d) **Convolutional codes** which are used for error correction depends not only on current input bits but also on past input bits (memory). Figure 2 shows a convolutional encoder with a constraint length of 3, consisting of 3 shift registers.

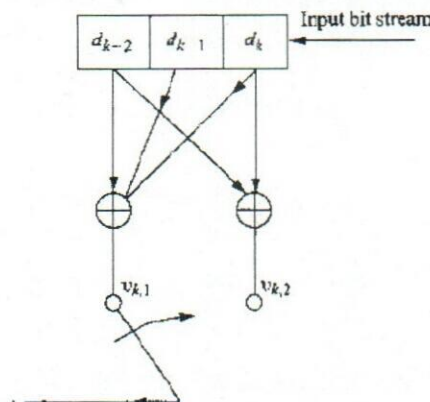


Figure 2: Convolutional Encoder

- (i) Illustrate the transitions in the convolutional encoder, between four (04) states namely, $a = 00$, $b = 01$, $c = 10$, $d = 11$ using a state transition diagram.

(05 Marks)

- (ii) Find the survivor path for a received bit sequence, 011011100000 using a trellis diagram. (Clearly show the trace of the survivor path on the trellis diagram.)

(08 Marks)

[Total - 35 Marks]

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.....**FORMULA SHEET**.....

Partial response signalling;

$$P_k = I_k \oplus P_{k-1} ; a_k = 2P_k - 1 ; b_k = a_k + a_{k-1}$$

Pulse shaping;

$$B_T = (1 + r) \frac{R_b}{2}$$

Toeplitz matrix for ZFE;

$$T = \begin{bmatrix} P_r[0] & P_r[-1] & \cdots & P_r[-2N+1] & P_r[-2N] \\ P_r[1] & P_r[0] & \cdots & P_r[-2N+2] & P_r[-2N+1] \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ P_r[2N] & P_r[2N-1] & \cdots & P_r[1] & P_r[0] \end{bmatrix}$$

For a 3-tap ZFE;

$$P_0 = \begin{bmatrix} z[-1] \\ z[0] \\ z[1] \end{bmatrix} ; C = \begin{bmatrix} C_{-1} \\ C_0 \\ C_1 \end{bmatrix} \text{ then, } P_0 = TC$$

Information theory;

$$L = \sum_{i=1}^n P_i L_i$$

$$H(m) = \sum_{i=1}^n P_i \log_2 \left(\frac{1}{P_i} \right)$$

Binary Symmetric Channel;

$$C_s = 1 - \left[P_e \log_2 \left(\frac{1}{P_e} \right) + (1 - P_e) \log_2 \left(\frac{1}{1 - P_e} \right) \right]$$

Linear Block Codes;

$$G = [I_{k(k \times k)} | P_{k(k \times m)}]_{k \times n} ; H = [P^T | I_k] ; c = dG$$

Systematic cyclic codes;

$$c(x) = x^{n-k}d(x) + \rho(x) ; \rho(x) = \text{Rem} \frac{x^{n-k}d(x)}{g(x)}$$

Convolutional encoder;

$$v_{k,1} = d_{k-2} \oplus d_{k-1} \oplus d_k ; v_{k,2} = d_{k-2} \oplus d_k$$

-END OF EXAMINATION PAPER-



CINEC Campus
Faculty of Engineering and Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
BSc Hons (Eng) Mechanical Engineering
BSc Hons (Eng) Mechatronic Engineering
Semester 07 First-Sit Examination 2024

Module Code : EE4313
Module Title : Dynamics, Design & Control of Robotics
Date : 5th December 2024
Examiners : Mr. Randeera Liyanage
Time Allowed : 9.00AM – 12.00PM; (3 Hours)

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 2 Parts. Part A contains 15 multiple choice questions (MCQ) and Part B contains 4 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 10 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.
- MCQ answer sheet. (Attached in Annex I)
- Manipulator schematic sheet, (Attached in Annex II)

PART A - MCQ**Instructions**

- You are required to answer all 15 MCQs given below.
 - You must indicate the correct answer on the MCQ answer sheet given in Annex I and attach it to your answer script.
 - Each question carries 01 mark.
1. You are tasked with designing a robotic system to assemble large cylindrical parts in a manufacturing plant. The task require consistent radial movement around the parts and the ability to perform vertical motions for assembly. Which robotic structure is MOST suitable for this application?
 - (a) Cartesian Robot
 - (b) Delta Robot
 - (c) Cylindrical Robot
 - (d) Articulated Robot
 2. Which of the following is a key advantage of using a feedback control system in motion control for robotic manipulators?
 - (a) Eliminates the need for sensors by relying on preprogrammed motions.
 - (b) Reduces computational complexity by simplifying trajectory planning.
 - (c) Ensures precise positioning by continuously monitoring and adjusting joint positions.
 - (d) Increases motion speed by avoiding intermediate calculations.
 3. In designing compliant joint controllers for robot manipulators, which of the following strategies best enable smooth interaction with uncertain environments while ensuring accurate trajectory tracking?
 - (a) Use proportional control alone to minimize steady-state error.
 - (b) Combine proportional and derivative control to respond to rapid changes and minimize overshoot.
 - (c) Rely solely on integral control to eliminate all system errors.
 - (d) Employ proportional-integral-derivative (PID) control to reduce steady-state error and maintain stability.

4. In trajectory planning, which approach ensures smooth and continuous movement of a robotic arm between multiple points while minimizing jerky motions and stress on the robot?
- (a) Planning linear segments with parabolic blends to maintain continuity in velocity and acceleration.
 - (b) Using joint-space trajectory planning with maximum angular velocities for each joint.
 - (c) Planning paths directly in Cartesian space without solving inverse kinematic equations.
 - (d) Employing stop-and-go motion between consecutive points to ensure precision.
5. Which of the following is a primary challenge in performing inverse perspective transformations in robotics and computer vision applications?
- (a) Difficulty in obtaining precise 2D coordinates of objects on the image plane.
 - (b) Loss of depth information ("z-axis") when converting from 3D to 2D during the perspective transformation process.
 - (c) Complex mathematical transformations are required to map 3D points onto a 2D plane.
 - (d) The inability of artificial intelligence techniques to predict depth information without using multiple cameras.
6. You are designing a robotic arm for precision assembly in a manufacturing plant. The arm must align and attach small components with high accuracy, requiring precise positional feedback. Which combination of sensors would you select to ensure reliable operation?
- (a) Encoders and Hall-effect sensors for position tracking and magnetic field detection.
 - (b) GPS for localization and strain gauges for monitoring joint forces.
 - (c) Potentiometers for position measurement and ultrasonic sensors for obstacle detection.
 - (d) Accelerometers for motion detection and inductive proximity sensors for the detection of metallic objects.
7. A mobile robot is being designed for warehouse navigation. It needs to identify obstacles, measure distances, and navigate autonomously while maintaining spatial awareness. Which sensors and techniques would be most appropriate for this application?
- (a) Optical proximity sensors for light detection, strain gauges for force sensing, and potentiometers for position tracking.
 - (b) GPS for location tracking, capacitive sensors for object detection, and accelerometers for stability control.
 - (c) LiDAR for mapping, ultrasonic sensors for distance measurement, and perspective transformation for spatial awareness.
 - (d) Radar for long-range detection, force-sensing resistors for collision feedback, and Cartesian trajectory planning.

8. You are assigned to design a robotic arm for a high-precision pick-and-place application that requires smooth, precise angular movements with minimal overshoot and high reliability. Which actuator type would be most suitable for this design?
- (a) Stepper motor with no feedback
 - (b) Brushless DC motor with feedback control
 - (c) Hydraulic actuator for high torque
 - (d) Pneumatic actuator for simplicity
9. For a mobile robot navigating a rugged environment, you need actuators with a high power-to-weight ratio and the ability to handle extreme conditions like heat and pressure variations. Which actuator system should you select?
- (a) Pneumatic actuators for simplicity and low weight
 - (b) Electric stepper motors for precise control
 - (c) DC brushed motors for reliability
 - (d) Hydraulic actuators for high power and ruggedness
10. A manufacturing company wants to integrate robots into their production line to work alongside human workers, assembling complex electronic products. Which of the following robotic trends would best suit their requirements?
- (a) Autonomous robots with AI-based navigation.
 - (b) Collaborative robots (cobots) designed for safe interaction with humans.
 - (c) Space robots for precise assembly in microgravity environments.
 - (d) Agricultural robots for handling fragile plants and products.
11. A healthcare startup is developing robotic systems for minimally invasive surgeries and physical rehabilitation. They require systems that are adaptable to delicate and complex tasks. Which emerging robotics trend is most suitable for this application?
- (a) Agricultural robotics for precise handling of fragile crops.
 - (b) Autonomous robots for decision making and navigation.
 - (c) Soft robotics for flexibility and adaptability.
 - (d) Telepresence robots for remote operation in hazardous environments.

12. You are tasked with designing an autonomous delivery robot for last-mile logistics in a densely populated urban area. Which combination of sensors and actuators is most suitable for ensuring precise navigation, obstacle avoidance, and package delivery?
- (a) Ultrasonic sensors for distance measurement, DC motors for mobility, and a gripper actuator for package handling.
 - (b) GPS for outdoor location, accelerometers for stability and a hydraulic arm for heavy lifting.
 - (c) LIDAR for environment mapping, brushless DC motors for energy-efficient mobility, and a soft robotic gripper for delicate packages.
 - (d) Optical sensors for visual feedback, pneumatic actuators for speed, and encoders for position tracking.
13. A manufacturing facility requires a robot system for high-speed pick-and-place operations on an assembly line. Which of the following robot design components is most suitable for this application?
- (a) SCARA robot for fast horizontal movements, optical sensors for part recognition, and stepper motors for precise control.
 - (b) Articulated robot for high dexterity, ultrasonic sensors for collision detection, and pneumatic actuators for rapid response.
 - (c) Cartesian robot for simple linear motion, magnetic proximity sensors for object detection, and hydraulic actuators for heavy loads.
 - (d) Delta robot for high-speed tasks, vision sensors for part tracking, and brushless DC motors for smooth operation.
14. A robot designed for autonomous inspection in an industrial facility requires image processing to identify defects in products under varying lighting conditions. Which stage of the image processing pipeline is critical for ensuring reliable defect detection despite poor illumination?
- (a) Segmentation to partition the image into meaningful regions.
 - (b) Feature extraction to abstract relevant image characteristics.
 - (c) Pre-processing to reduce noise and enhance critical features.
 - (d) Matching to compare the processed image with reference models.
15. In an omnivision system designed for autonomous drones operating in remote areas, edge computing is critical for real-time decision making. Which of the following is a primary advantage of integrating edge AI with omnivision in such systems?
- (a) Reduced power consumption and extended flight time.
 - (b) Enhanced ability to process omnidirectional data without relying on cloud services, reducing latency.
 - (c) Improved resolution of panoramic images captured by the omnivision system.
 - (d) Simplified camera calibration and alignment in omnivision setups.

[Total - 30 Marks]

PART B - ESSAY**Question 01**

The structure of an RPR manipulator is shown in Figure 1.

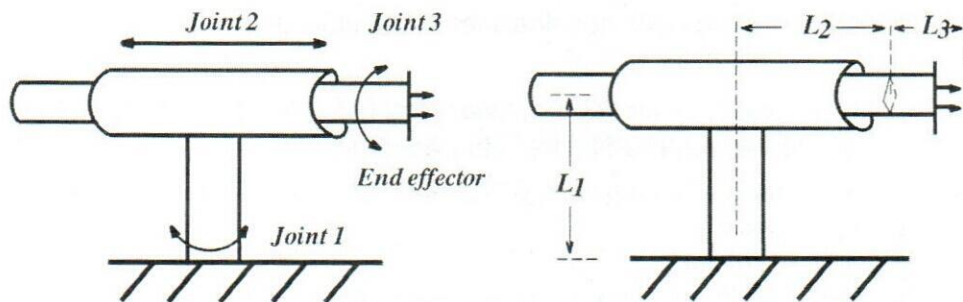


Figure 1: RPR Manipulator

- Assign suitable frames according to the Modified Denavit-Hartenberg convention including the reference frame. *(You are required to use the manipulator schematic sheet in Annex II for the frame assignment and attach it to the answer script.)* (05 Marks)
- Determine the Modified Denavit-Hartenberg table for the assigned frames. (05 Marks)
- Determine an expression for the homogeneous transformation which describes the forward kinematics of the manipulator. *(You may leave the final answer as a multiplication of 3 matrices.)* (04 Marks)
- Explain the significance of inverse kinematics in robotic manipulator design and how it differs from forward kinematics. *(Use 3 sentences for your answer.)* (03 Marks)
- Define the concept of the Dextrous workspace and reachable workspace in the context of robotic manipulators. Discuss how these workspaces impact the feasibility of solving inverse kinematics problems. *(Use a minimum of 4 bullet points for your answer.)* (04 Marks)
- Explain the challenges posed by multiple solutions in inverse kinematics and describe how these challenges can be addressed in practical applications. *(Use a minimum of 4 bullet points for your answer.)* (04 Marks)

[Total - 25 Marks]

Question 02

- (a) Discuss how the choice of control parameters (proportional, integral, and derivative gains) affects the stability and response of the robotic arm's motion control system. *(Use at least 4 bullet points for your answer.)*
(04 Marks)
- (b) Discuss the importance of resolution, sensitivity, and response time as sensor characteristics in designing a robotic manipulator for industrial applications. *(Use at least 3 bullet points for your answer.)*
(03 Marks)
- (c) Design a comprehensive sensor suite for an industrial pick-and-place robot. In your answer, specify the types of sensors you would include, their placement on the robot, and the role each sensor that plays in enhancing accuracy, precision, and overall operational efficiency. *(Use approximately 100 words.)*
(05 Marks)
- (d) Explain the trade-offs between stiffness and compliance in actuators for robotic systems. How do these characteristics influence robot design in precision applications such as assembling small components? *(Use at least 4 sentences for your answer.)*
(04 Marks)
- (e) Design an actuator system for a robotic manipulator specifically intended for assembling electronic chips. Your answer should include: The type of actuators selected and a justification for their use, key features of the actuator system, such as feedback mechanisms and design considerations specific to chip assembly. *(Use approximately 100 words.)*
(04 Marks)

[Total - 20 Marks]

Question 03

- (a) Compare the advantages and limitations of using omnivision with rotating cameras, multiple cameras, and fisheye lenses when designing a robot for warehouse navigation.
(06 Marks)
- (b) Discuss the role of preprocessing and segmentation in improving image processing efficiency for robots performing object detection and recognition tasks in manufacturing environments. *(Use at least 4 sentences in your discussion.)*
(04 Marks)
- (c) Evaluate the use of application-oriented robot system design in tailoring robots for medical applications, such as surgery or rehabilitation, highlighting key design considerations for sensors, actuators, and control systems. *(Use at least 1 detailed bullet point per design consideration.)*
(03 Marks)
- (d) Analyze how advancements in collaborative robots and soft robotics are shaping future trends in robotic design, particularly in unstructured environments like agriculture or disaster recovery. *(Use approximately 150 words for the answer.)*
(07 Marks)

[Total - 20 Marks]

Question 04

- (a) Discuss the differences between joint-space trajectory planning and Cartesian-space trajectory planning in robotic systems. Highlight their computational challenges, use cases, and advantages. Based on these, propose which approach is better suited for tasks requiring high precision in end-effector movement, such as welding or surgical applications. *(Use approximately 100 words for the answer.)* (04 Marks)
- (b) A planar robotic arm with two revolute joints is tasked with moving its end effector from an initial position $\theta_1(0) = -19$, $\theta_2(0) = 44$ to a final position $\theta_1(tf) = 43$, $\theta_2(tf) = 151$ in 2 seconds. The arm consists of two links of lengths $L_1 = 4$ and $L_2 = 3$. Using a 5th-order polynomial trajectory planning method, derive the angular trajectory expressions (position, velocity, and acceleration) of both joints. (04 Marks)
- (c) Given the Jacobian matrix J of a robot at a particular time, calculate the linear and angular differential motions of the robot's hand frame for the specified joint differential motions. The Jacobian matrix J and the differential joint motion vector D_θ are provided in Equation 1.

$$J = \begin{bmatrix} 20 & 0 & 0 & 0 & 0 & 0 \\ -7 & 0 & 1 & 0 & 0 & 0 \\ 0 & 15 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} ; D_\theta = \begin{bmatrix} 0 \\ 0.1 \\ 0 \\ -0.1 \\ 0.05 \\ 0.03 \end{bmatrix} \quad (1)$$

(06 Marks)

- (d) Given the hand frame of a 5-DOF robot (2RP2R configuration) with a Jacobian matrix (J_6) and a set of differential joint motions as specified in Equation 2, determine the new location of the hand after a differential motion.

$$T_6 = \begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & 0 & -1 & 3 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix} J_6 = \begin{bmatrix} 3 & 0 & 0 & 0 & 0 \\ -2 & 0 & 1 & 0 & 0 \\ 0 & 4 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ -1 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} d\theta_1 \\ d\theta_2 \\ d_{s3} \\ d\theta_4 \\ d\theta_5 \end{bmatrix} = \begin{bmatrix} 0.1 \\ -0.1 \\ 0.05 \\ 0.1 \\ 0 \end{bmatrix} \quad (2)$$

(06 Marks)

[Total - 20 Marks]

Reference Equations

- Rotation about z, y and x axes by an angle θ :

$$Rot_z(\theta) = \begin{bmatrix} \cos \theta & -\sin \theta & 0 & 0 \\ \sin \theta & \cos \theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad Rot_y(\theta) = \begin{bmatrix} \cos \theta & 0 & \sin \theta & 0 \\ 0 & 1 & 0 & 0 \\ -\sin \theta & 0 & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$Rot_x(\theta) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos \theta & -\sin \theta & 0 \\ 0 & \sin \theta & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

- Forward kinematic solution:

$${}^{i-1}T_i = Rot_x(\alpha_{i-1}) \cdot Trans(a_{i-1}, 0, 0) \cdot Rot_z(\theta_i) \cdot Trans(0, 0, d_i)$$

- Robot Jacobian

$$\begin{bmatrix} dx \\ dy \\ dz \\ \delta x \\ \delta y \\ \delta z \end{bmatrix} = [\text{Robot Jacobian}] \begin{bmatrix} d\theta_1 \\ d\theta_2 \\ d\theta_3 \\ d\theta_4 \\ d\theta_5 \\ d\theta_6 \end{bmatrix} ; [D] = [J][D_\theta]$$

- Differential Operator

$$\Delta = Trans(dx, dy, dz) \times Rot(q, d\theta) - I ; \Delta = \begin{bmatrix} 0 & -\delta z & \delta y & dx \\ \delta z & 0 & -\delta x & dy \\ -\delta y & \delta x & 0 & dz \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$[dT] = [\Delta][T] ; [{}^T\Delta] = [T]^{-1}[\Delta][T] ; T_{new} = T_{old} + dT ; {}^T\Delta = T_1^{-1} \cdot \Delta \cdot T_1$$

- Procedure for Frame Attachment

- Link Length (a_i) – The distance from z_i to z_{i+1} along x_i .
- Twist Angle (α_i) – The angle from z_i to z_{i+1} about x_i .
- Joint Offset (d_i) – The distance from x_{i-1} to x_i along z_i .
- Joint Angle (θ_i) – The angle from x_{i-1} to x_i about z_i .

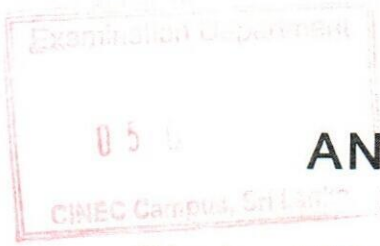
- DH Table

i	α_{i-1}	a_{i-1}	θ_i	d_i
1				
2				
3				

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ANNEX I - MCQ ANSWER SHEET

Student ID:.....

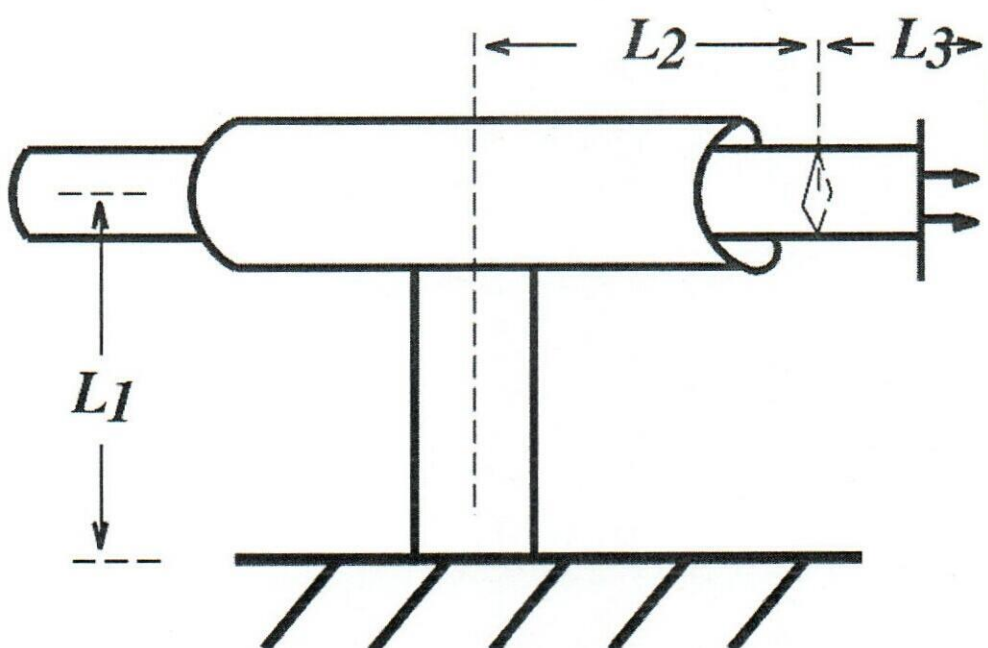
Instructions - Shade the correct letter using a pencil.

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
8. ☐ A ☐ B ☐ C ☐ D
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

ANNEX II - MANIPULATOR SCHEMATIC SHEET

Note: You are required to attach this sheet to the answer script.

Student ID:

Part B Question 1 Manipulator Schematic

- END OF MANIPULATOR SCHEMATIC SHEET -



CINEC Campus
Faculty of Engineering & Technology
Department of Electronics Engineering
BSc Hons (Eng) Automotive, Mechanical, Civil, Mechatronics, Electronic
& Telecommunication Engineering
Semester 07 / First Sit / Written Exam / 2024

Module Code	:	FE4311
Module Title	:	Ethics in Engineering
Date	:	03 rd Dec 2024
Examiners	:	Eng. Wipula Wimalshanthi
Time Allowed	:	03 hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of two (02) 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 three (03) pages.

MATERIALS REQUIRED

- CINEC answering Booklet, Extra answering paper
- You may use copies of By-Laws of the Institution of Engineers, Sri Lanka (IESL), Code of Ethics and Rules provided during the examination

Question 1

- i) State the definition of an Engineer.

Discuss the significance of scientific knowledge over the other aspects of engineering profession using an appropriate Venn diagram.

Define Ethics in Engineering in your own words.

[06 Marks]

- ii) Identify six (06) characteristics of a successful engineer paraphrasing each characteristic as per your understanding.

[06 Marks]

- iii) Taking an example of a failed national engineering project in Sri Lanka, discuss the reasons for failure of the project in question. In your opinion, what should have been done to avoid such an outcome of this project and to deliver its benefits to the country.

[10 Marks]

- iv) Explain the manner in which sustainable management of resources and the protection of environment are made part of the Code of Ethics published by IESL. What are the related Rules published by IESL in this regard? (You may refer the Appendix I of the By-laws of IESL in answering this question.)

[08 Marks]

- v) State four (04) examples of professional values and identify the skills and behaviours that would contribute towards developing them. Discuss the ways in which professional values would positively impact customer relations.

[10 Marks]

Question 2

Read the Case given below carefully and answer the questions given at the end.

The Green Energy Initiative:

Background:

The Green Energy Initiative is a national project in Sri Lanka aimed at promoting renewable energy sources such as solar and wind power. The project is spearheaded by a team of engineers led by Ms. Kamala, a senior electrical engineer. The team is tasked with designing and implementing a comprehensive solar power solution for a rural community that has limited access to electricity.

Scenario:

During the project's design phase, Ms. Kamala discovers that a subcontractor has proposed using cheaper, less efficient solar panels that do not meet the specified energy output criteria. The subcontractor argues that using these panels could significantly reduce costs and accelerate project completion.

Ms. Kamala feels conflicted since implementing the cheaper panels could save money but also risks compromising energy efficiency and the long-term sustainability of the project.

- i) What are the ethical issues involved with this case that are in line with the Code of Ethics of IESL?
- ii) What immediate action should Ms. Kamala take upon discovering the use of substandard solar panels?
- iii) How can Ms. Kamala ensure that the project adheres to the core principle of sustainability?
- iv) If Ms. Kamala's concerns are ignored by management, what steps can she take to uphold her ethical responsibilities?
- v) How can Ms. Kamala promote the ethical standards of the engineering profession through her actions?

[40 Marks]

Disclaimer: The case given above is totally fictitious and has no relation to any organizations or living / deceased persons.

Appendix I of IESL By-Laws

CODE OF ETHICS

1. Engineers shall hold paramount the health, safety and welfare of the public and proper utilization of the funds and other resources in the performance of their professional duties. It shall take precedence over their responsibility to the profession, sectoral or private interests, employers or to other engineers.
2. Engineers shall always act in such a manner as to uphold and enhance the honour, integrity and dignity of the profession while safeguarding public interest at all times.
3. Engineers shall be committed to the need for sustainable management of the planet's resources and seek to minimize adverse environmental impacts of their engineering works or applications of technology so as to protect both present and future generations.
4. Engineers shall build their reputation on merit and shall not compete unfairly.
5. Engineers shall perform professional services only in the areas of their competence.
6. Engineers shall apply their skills and knowledge in the interest of their employer or client for whom they shall act, in professional matters, as faithful agents or trustees, so far as they do not conflict with the other requirements listed here and the general public interest.
7. Engineers shall give evidence, express opinions or make statements in an objective and truthful manner.
8. Engineers shall continue their professional development throughout their careers and shall actively assist and encourage engineers under their direction to advance their knowledge and experience.

RULES

Clause 1

Engineers shall hold paramount the health, safety and welfare of the public and proper utilization of the funds and other resources in the performance of their professional duties. It shall take precedence over their responsibility to the profession, sectoral or private interests, employers or to other engineers.

As the first requirement places the interests of the community above all others, Engineers –

- | | |
|-----------------|--|
| Rule 1.1 | Shall be objective and truthful in writing professional reports, issuing statements or submitting testimony. They shall include all relevant and pertinent information in such reports, statements or testimony. |
| Rule 1.2 | Shall endeavour at all times to maintain engineering services essential to public welfare. |
| Rule 1.3 | Shall work in conformity with recognized engineering standards so as not to jeopardize the health, safety and welfare of the public. |
| Rule 1.4 | Shall not participate in assignments that would create conflict of interest between their clients / employers and the public and shall advise the client of their concerns. |
| Rule 1.5 | Shall, in the event of their judgment being over-ruled in matters pertaining to health, safety and welfare of the community, inform their clients or employers of the possible consequences and bring to the clients' / employers' notice their obligations as professionals to inform the relevant authority. |
| Rule 1.6 | Shall contribute to public discussion on engineering matters in their areas of competence; if they consider that by so doing they can constructively advance the wellbeing of the community. |
| Rule 1.7 | Having knowledge of any alleged violation of this Code by others shall co-operate with the proper authorities in furnishing such information or assistance as may be required. |
| Rule 1.8 | Shall not knowingly participate in any act, which will result in waste or misappropriation of public funds. |
| Rule 1.9 | Shall actively contribute to the wellbeing of the society and, when involved, in any engineering project or application of technology, shall, where appropriate, recognize the need to identify, inform and consult affected parties to help resolve problems involved. |

Clause 2

Engineers shall always act in such a manner as to uphold and enhance the honour, integrity and dignity of the profession while safeguarding public interest at all times.

This requires that the engineering profession should endeavour by its behaviour to merit the highest esteem of the community. It follows therefore, that engineers:

- Rule 2.1** Shall not involve themselves with any business or professional practice, which they know to be fraudulent or dishonest in nature.
- Rule 2.2** Shall not associate with other persons, corporations or partnerships to conceal unethical acts.
- Rule 2.3** Shall not continue in partnership with, or act in professional matters with any engineer who has been removed from membership of this Institution because of improper conduct.
- Rule 2.4** Shall promote the principle of engagement of engineers upon the basis of merit.
- Rule 2.5** Shall uphold the principle of adequate and appropriate remuneration for professional engineering staff in keeping with their qualifications and market price.

Clause 3

Engineers shall be committed to the need for sustainable management of the planet's resources and seek to minimize adverse environmental impacts of their engineering works or applications of technology so as to protect both present and future generations.

To this end engineers –

- Rule 3.1** Shall carefully evaluate adverse environmental impacts *of their actions* and incorporate practical remedial measures to minimize them.
- Rule 3.2** Shall consider theoretical, legislative, regulatory and policy aspects of environmental protection and sustainable management of the available resources.
- Rule 3.3** *Shall work in close co-operation with members of other professions and disciplines on achieving sustainable development.*
- Rule 3.4** Shall critically analyze how the proposed project or the application of technology relates to sustainability considerations.
- Rule 3.5** Shall identify and assess options for material recovery and disposal.
- Rule 3.6** Shall analyze opportunities for resource and energy conservation and, design appropriately optimized systems.

Clause 4

Engineers shall build their reputation on merit and shall not compete unfairly.

This requirement is to ensure that engineers shall not seek to gain a benefit by improper means. It follows that engineers-

- Rule 4.1** Shall neither pay nor offer, directly or indirectly, inducements to others.
- Rule 4.2** Shall not attempt to supplant another engineer, employed or consulting, who has been appointed, without his consent.
- Rule 4.3** Shall neither falsify nor misrepresent their own or other's qualifications, experience and prior responsibilities.
- Rule 4.4** Shall respect others and not maliciously do anything to tarnish, directly or indirectly, the reputation, prospects or business of others.
- Rule 4.5** Shall not use the advantage of a privileged position to compete unfairly with other engineers.
- Rule 4.6** Shall exercise due restraint in explaining their own work and shall refrain from unfair criticism of the work of other engineers.
- Rule 4.7** Shall give proper credit for professional work to those to whom credit is due.
- Rule 4.8** Shall not resort to any form of plagiarism in their work. (new) This includes use of such materials as written text, statistics or similar data, diagrams, illustrations and photographs in reports, publications, examination answers, coursework submitted for academic or professional qualifications etc., without permission, acknowledgement or reference, as if it is the person's own work.
- Rule 4.9** Shall act with due regard to intellectual property rights of others in their work.
- Rule 4.10** Shall not engage in unfair competition including charging of extremely high or low professional fees compared to market rates, in delivering professional services

Clause 5

Engineers shall perform professional services only in the areas of their competence.

To this end engineers –

- Rule 5.1** Shall undertake assignments only when qualified by education and experience in the specific technical fields involved. If an assignment requires qualifications and experience outside their fields of competence they shall engage competent professionals with necessary qualifications and experience and keep the employers and clients informed of such arrangements.
- Rule 5.2** Shall not affix their signature to any designs or documents dealing with subject matter in which they lack competence, or to any plan or document not prepared under their direction or control.

Clause 6

Engineers shall apply their skills and knowledge in the interest of their employer or client for whom they shall act, in professional matters, as faithful agents or trustees, so far as ft they do not conflict with the other requirements listed here and the general public interest.

It follows that engineers –

- Rule 6.1** Shall at all times avoid all known or potential conflicts of interest that involve the engineer himself. They should keep their employers or clients fully informed on all matters, including financial interests, which could lead to such a conflict, and under no circumstances should they participate in any decision which could involve them in conflict of interest.
- Rule 6.2** Shall when acting as administrators of a contract be impartial between the parties in the interpretation of the contract. This requirement of impartiality shall not diminish
- Rule 6.3** Shall not accept compensation, financial or otherwise from more than one party for services on the same project, unless the circumstances are fully disclosed and agreed to, by all interested parties.
- Rule 6.4** Shall neither solicit nor accept financial or other valuable consideration, including free engineering designs, from material or equipment suppliers for specifying their products (except such designs obtained with the knowledge and consent of the employer or client).
- Rule 6.5** Shall neither solicit nor accept gratuities, directly or indirectly from contractors or their agents, or other parties dealing with their clients or employers in connection with work for which they are responsible.
- Rule 6.6** Shall not accept a commission, fee, reward or other benefit from a Third Party, while advising a client.
- Rule 6.7** Shall advise their clients or employers when as a result of their studies they believe that a project will not be viable.
- Rule 6.8** Shall neither disclose nor use confidential information gained in the course of their employment without express permission, except where public interest and safety are involved.
- Rule 6.9** Shall not complete, sign, or seal designs and/or specifications that are not safe to the public health and welfare and in conformity with accepted engineering standards. If the client or employer insists on such unprofessional conduct, they shall notify the proper authorities and withdraw from further service on the project.

Clause 7

Engineers shall give evidence, express opinions or make statements in an objective and truthful manner.

It follows that –

Rule 7.1

Engineers professional reports, statements or testimony before any tribunal shall be objective and such opinions shall be expressed only on the basis of adequate knowledge and technical competence in the area, but this does not preclude a considered judgment based intuitively on experience and wide relevant knowledge.

Rule 7.2

Engineers shall reveal the existence of any interest, pecuniary or otherwise that could be taken to affect their judgment in a technical matter about which they are making a statement or giving evidence.

Clause 8

Engineers shall continue their professional development throughout their careers and shall actively assist and encourage engineers under their direction to advance their knowledge and experience.

It follows therefore, that engineers –

Rule 8.1

Shall encourage their professional employees and subordinates to further their education, and

Rule 8.2

Shall take a positive interest in and encourage their fellow engineers actively to support the Institution and other bodies, which further the general interest of the profession.

GUIDELINES FOR PROFESSIONAL CONDUCT

1. Engineers shall be guided in all their professional relations by the highest standards of integrity.
 - a. Engineers shall admit and accept their own errors when proven wrong and refrain from distorting or altering the facts in an attempt to justify their decisions.
 - b. Engineers shall advise their clients or employers when they believe a project will not be successful.
 - c. Engineers shall not accept assignments outside their employment to the detriment of their regular work or interest. Before accepting any assignments outside their employment they will notify their employers and obtain their prior permission.
 - d. Engineers shall avoid any act tending to promote their own interest at the expense of the dignity and integrity of the profession.
2. Engineers shall at all times strive to serve the public interest.
 - a. Engineers shall seek opportunities to be of constructive service in civil affairs and work for the advancement of the safety, health and well being of their community.
 - b. In public or private sector employment engineers shall refrain from participating knowingly in any act that will result in waste or misappropriation of employers funds.
3. Engineers shall refrain from all conduct or practice which is likely to discredit the profession or deceive the public.
 - a. Engineers shall refrain from using statements containing material misrepresentation of fact, or omitting material fact.
 - b. Engineers shall refrain from showmanship, or self-laudation or from attempting to attract clients thereby and making derogatory statements about others. Consistent with the foregoing Engineers may advertise for recruitment of personnel.
 - c. Consistent with the foregoing. Engineers may publish articles in the press or in technical journals but such articles shall not imply credit to the author for work performed by others.
4. Engineers shall not disclose confidential information concerning the business affairs or technical processes of employers without their consent.
5. Engineers shall not be influenced in their professional duties by conflicting interests.
 - a. Engineers shall not accept financial or other considerations, from material or equipment suppliers for specifying their product
 - b. Engineers shall not accept commissions or allowances, directly or indirectly from contractors or other parties in connection with the work for which the Engineer is responsible.
 - b. Consistent with the foregoing Engineers may publish articles in the press on in technical journals but such articles shall not imply credit to the author for work performed by others.
6. Engineers shall uphold the principle of appropriate and adequate compensation for those engaged in engineering work.
 - a. Engineers shall not accept remuneration from either an employee or employment agency for giving employment.
 - b. Engineers, when employing other engineers, shall offer a salary according to professional qualifications, experience and recognised standards.
7. Engineers shall not compete unfairly with other engineers to obtain employment or advancement in employment or in seeking professional engagements by taking advantage of their position, by criticizing other engineers, or by other improper or questionable means.

- a. Engineers shall not request, propose, or accept a professional commission under circumstances in which their professional judgment may be compromised.
 - b. Engineers in salaried position shall accept part-time engineering work only with the expressed permission of the employer and at recognised rates for such work.
 - c. Engineers shall not use equipment, supplies laboratory, or office facilities of an employer to carry out outside private work without the consent of the employer.
8. Engineers shall not attempt to injure, maliciously or falsely, (directly or indirectly) the professional reputation, prospects, practice or employment of other engineers, nor indiscriminately criticize other engineers' work. Engineers who believe others are guilty of unethical or illegal practice shall present such information to the proper authority for action.
- a. Engineers in private practice shall not review the work of another engineer for the same client, except with the knowledge of such engineer, or unless the connection of such engineer with the work has been terminated for unethical practices.
 - b. Engineers in governmental, industrial or educational employ are entitled to review and evaluate the work of other engineers when so required by their employers.
 - c. Engineers in sales or industrial employ shall not criticize products of other manufacturers which are similar to their own.
9. Engineers shall accept personal responsibility for their professional activities.
- a. Engineers shall conform with state registration laws in the practice of engineering.
 - b. Engineers shall not use association with a non-engineer, a corporation, or partnership, as a „cloak“ for unethical acts, but must accept personal responsibility for their professional acts.
10. Engineers shall give credit for engineering work of other engineers to whom credit is due, and will recognise the proprietary interests of others.
- a. Engineers shall, when possible, name the person or persons who may be individually responsible for designs, inventions, writings, or other accomplishments.



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Automotive / Civil / Electronic & Telecommunication /
Mechanical Engineering
Semester 1 First Sit Examination 2024

Module Code	:	EE1315	Electricity
Module Title	:	Mechanical Engineering	
Date	:	29 th November 2024	
Examiners	:	G. S. Samarakkody	
Time Allowed	:	3 hours	

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of **5** 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 5 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. Electrical engineering principles form the foundation for modern technologies and innovations.

a. Define and explain the following basic electrical quantities:

- i. Current
- ii. Voltage
- iii. Resistance

(6 marks)

b. Discuss the importance of the International System of Units (SI) in electrical engineering.

(4 marks)

Q2. The understanding and application of fundamental electrical laws are essential in analysing electrical circuits. Address the following aspects:

- State Ohm's Law and explain its significance in circuit analysis. (4 marks)
- Explain the generalized Ohm's Law, illustrating its application with a suitable equation and diagram. (6 marks)
- State Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL), highlighting their importance in electrical circuit analysis. (6 marks)
- Using the circuit shown in Figure 2.1, apply KCL and KVL to calculate the current values I_1 , I_2 and I .

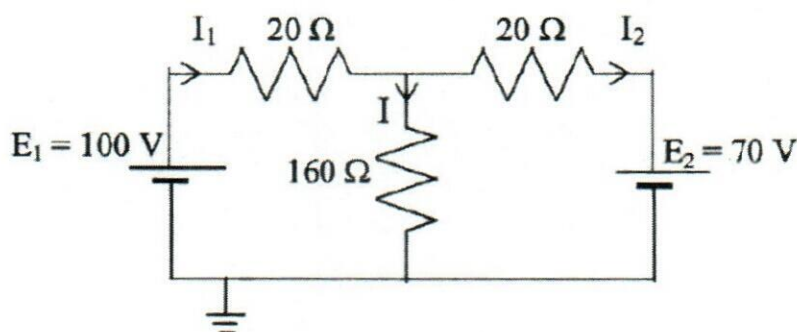


Figure 2.1

(9 marks)

Q3.

- a. A $1\text{k}\Omega$ resistor, a 142mH coil and a $160\mu\text{F}$ capacitor are all connected in parallel across a 240V , 60Hz supply as shown in Figure 3.1. Calculate the impedance of the parallel RLC circuit and the current drawn from the supply.

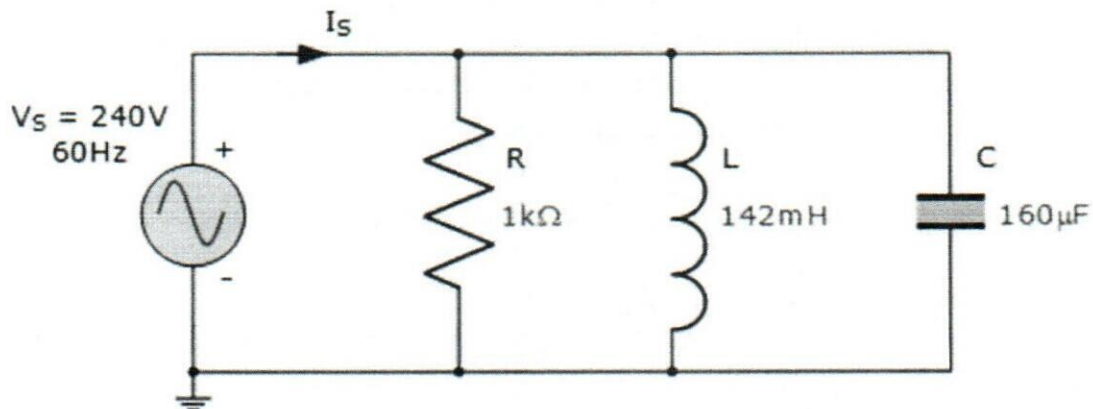


Figure 3.1

(15 marks)

- b. A series RLC circuit containing a resistance of 12Ω , an inductance of 0.15H and a capacitor of $100\mu\text{F}$ are connected in series across a 100V , 50Hz supply as shown in Figure 3.2. Calculate the total circuit impedance, the circuit's current, power factor and draw the voltage phasor diagram.

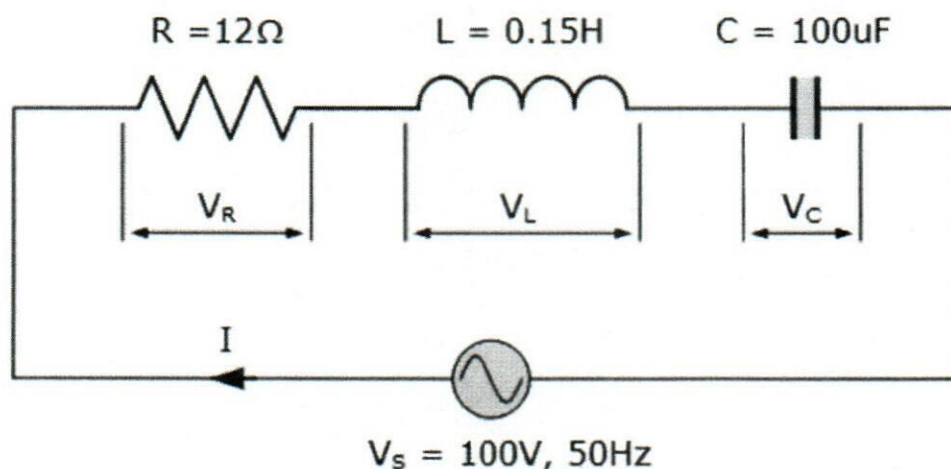


Figure 3.2

(20 marks)

Q4. Electrical systems rely on accurate measurement of electrical quantities, proper installation of electrical components, and adequate protective measures to ensure safety and functionality.

- a. Describe the methods and instruments used to measure the following electrical quantities:
- Current
 - Voltage
 - Resistance

(6 marks)

- b. Explain the key considerations and steps involved in installing electrical components in a residential or industrial setup.

(6 marks)

Q5.

- a. Calculate the force between two charges $q_1 = +5 \mu\text{C}$ and $q_2 = -6 \mu\text{C}$ which are separated by a distance of 0.3 m.

(5 marks)

- b. Calculate the electric potential at 0.3m from a charge of $+3 \mu\text{C}$.

(4 marks)

- c. Calculate the energy stored in a $10 \mu\text{F}$ capacitor with a potential difference of 15V.

(4 marks)

- d. A circular loop of radius 0.2m carries a current of 5A. Calculate the magnetic field at the center of the loop.

(5 marks)



Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Automotive / Electronics & Telecommunication /
Mechanical / Mechatronics Engineering
Year 4 Semester 7 First Sit Final Examination 2024

Module Code	:	EE4315
Module Title	:	Industrial Instrumentation
Date/Time	:	28 th November 2024/ 09.00 am – 12.00 pm
Examiners	:	Gresha S. Samrakkody
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.
- This paper contains 5 pages.

MATERIALS REQUIRED

- Answering Booklet

Student Number

Q1.

- a. Define "Industrial Instrumentation" and explain its significance in industrial applications.
(6 marks)
- b. Identify any five (5) key variables involved in "Process Control and Optimization" and list the instruments commonly used to measure each variable.
(5 marks)
- c. Describe a real-world scenario where remote monitoring and automation are applied. Explain how the identified variables and measurements are monitored and utilized to ensure system efficiency and reliability.
(6 marks)

Q2.

- a. Describe the main functional elements required to design an industrial instrument, providing an example of its application in a real-world industrial scenario.
(5 marks)
- b. Based on the example provided in Q2.a), design a suitable control system configuration for the process. Specify whether an open-loop or closed-loop configuration is more appropriate. Justify your choice by analysing the design requirements and system characteristics.
(8 marks)
- c. Propose two (2) specific design modifications or techniques to enhance the performance of the system. For each proposed modification or technique, explain how it improves the system's functionality, reliability, or efficiency.
(5 marks)

Q3. An industrial process requires continuous monitoring of liquid flow in a pipeline.

- a. Identify a suitable type of sensor for this application and explain the principle behind its operation.

(6 marks)

- b. Discuss how this sensor's output could be integrated into an instrumentation system for real-time flow rate monitoring.

(6 marks)

Q4. Home automation is a method of controlling home appliances automatically for the convenience of users. This technology makes life easier for the user and saves energy by utilizing devices according to strict requirements. Controls can be as basic as switching lights ON or OFF based on the movements of people to more advanced setups, such as programming the home using a main controller or controlling devices via cell phone from anywhere in the world. A home automation system can involve switching off electrical appliances like air-conditioners or refrigerators when a desired temperature has been reached, and then switching them back on when the temperature exceeds a certain value. A home automation system can also be used to secure a house from burglars by sending alerts to the nearest police station and the homeowner in case a trespasser is sensed. (Consider a PLC based home automation system to answer the questions below.)

- a. Describe the role of Analog to Digital Converter (ADC) and Digital to Analog Converters (DAC) in above automated systems.

(6 marks)

- b. Name any ADC type that is suitable for above scenario and explain its operation.

(7 marks)

- c. Name any DAC type that is suitable for above scenario and explain its operation.

(7 marks)

Q5.

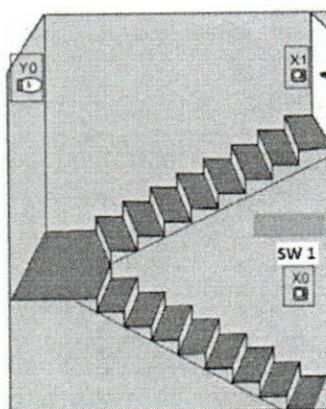
- a. Develop the ladder logic diagram for an “AND” operation in a 2-input system.

(5 marks)

- b. Develop the ladder logic diagram for a “NOR” operation in a 2-input system.

(5 marks)

- c. The below Figure 1 shows a system which “switches the lamp ON/OFF depending on whether it is at the bottom or the top of the staircase”. Explain the operation of the ladder logic diagram (shown in Figure 2) developed for this system.



(8 marks)

Figure 1: System of Switching on/off the Lamp whether they are at the bottom or the top of the staircase.

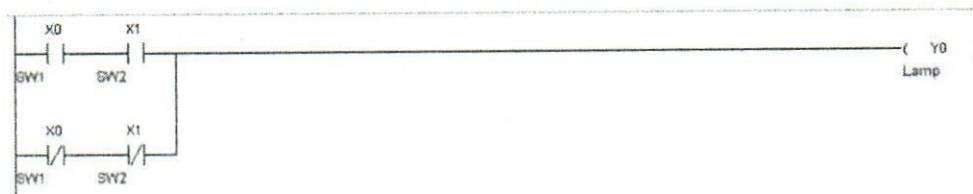


Figure 2: Ladder Logic Diagram of the System

- d. What are the rules and practices that you have utilize while developing above ladder logic diagram?

(5 marks)

Q6.

- a. Define the terms **systematic error** and **random error** and provide one example for each.

(4 marks)

- b. A pressure gauge is used in a factory environment where ambient temperature varies significantly.

- i. Discuss how temperature variations might affect the accuracy of the pressure readings.

(3 marks)

- ii. Suggest two (2) error-handling techniques to mitigate this issue.

(3 marks)

END OF THE PAPER



**Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Automotive / Electronics & Telecommunication /
Mechanical / Mechatronics Engineering
Year 4 Semester 7 First Sit Final Examination 2024**

Module Code	:	EE4315
Module Title	:	Industrial Instrumentation
Date/Time	:	28 th November 2024/ 09.00 am – 12.00 pm
Examiners	:	Gresha S. Samrakkody
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.
- This paper contains 5 pages.

MATERIALS REQUIRED

- Answering Booklet

Student Number

Q1.

- a. Define "Industrial Instrumentation" and explain its significance in industrial applications.
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(7 marks)

- c. Name any DAC type that is suitable for above scenario and explain its operation.

(7 marks)

Q5.

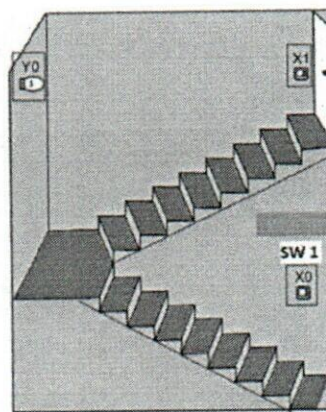
- a. Develop the ladder logic diagram for an “AND” operation in a 2-input system.

(5 marks)

- b. Develop the ladder logic diagram for a “NOR” operation in a 2-input system.

(5 marks)

- c. The below Figure 1 shows a system which “switches the lamp ON/OFF depending on whether it is at the bottom or the top of the staircase”. Explain the operation of the ladder logic diagram (shown in Figure 2) developed for this system.



(8 marks)

Figure 1: System of Switching on/off the Lamp whether they are at the bottom or the top of the staircase.



Figure 2: Ladder Logic Diagram of the System

- d. What are the rules and practices that you have utilized while developing above ladder logic diagram?

(5 marks)

Q6.

- a. Define the terms **systematic error** and **random error** and provide one example for each.

(4 marks)

- b. A pressure gauge is used in a factory environment where ambient temperature varies significantly.

- i. Discuss how temperature variations might affect the accuracy of the pressure readings.

(3 marks)

- ii. Suggest two (2) error-handling techniques to mitigate this issue.

(3 marks)

END OF THE PAPER



CINEC CAMPUS
Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Semester 8 Re-Sit Final Examination 2024

Module Code	:	EE4321
Module Title	:	Wireless and Mobile Communications
Date	:	09 th September 2024
Examiners	:	Srimal Punchihewa
Time Allowed	:	1300-1600; 3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 4 Questions. Answer **ALL** questions.
- Write clearly legibly with a blue or black pen.
- Use only the answering sheets provided by CINEC.
- This paper contains 5 pages.
- Each question carries equal marks.

MATERIALS REQUIRED

- Answering sheets provided by CINEC.
- You may use a scientific calculator. This must not be programmable. This may be inspected during the Examination.

- 1 (a) In Mobile Communications, signal from the transmitter will not reach the receiver in a line-of-sight.
Briefly explain the reasons for the above.
(3 Marks)
- (b) Whenever the signal hits an obstacle, three possible things can happen.
Name them.
Explanation is not required.
(3 Marks)
- (c) What happens when a signal hits an obstacle depends on the nature of the obstacle surface.
For each of the three possible things named in (b) above, write down nature of the obstacle.
(9 Marks)
- (d) When a user carries a mobile phone and move a small distance, the received power changes with the distance to the transmitter.
Write down the name of this phenomenon.
Explanation is not required.
(2 Marks)
- (e) When a user carries a mobile phone and move a large distance, such as from one city to another, the received power changes with the distance to the transmitter.
Write down the name of this phenomenon.
Explanation is not required.
(2 Marks)
- (f) Draw a graph between received power versus distance and show the phenomena (d) and (e) above.
Explanation is not required.
(6 Marks)
(Total 25 Marks)

2. (a) In mobile communications, instead of one large power transmitter we use several low power transmitters called base stations.
Write down the name of this method.
Explanation is not required.
(3 Marks)
- (b) Draw diagrams of "edge excited cell" and "centre excited cell"
Explanation not required.
(6 Marks)
- (c) What happens when a mobile moves into a different cell while a conversation is in progress?
Write your answer in two sentences.
(6 Marks)
- (d) What is "dwell time"?
Write your answer in three sentences.
(5 marks)
- (e) What is "mobile assisted handoff"?
Write your answer in three sentences.
(5 Marks)
(Total 25 Marks)

3. (a) Each Wi-Fi network standard is having "Speed" and "Frequency" as parameters. Briefly explain the same. (3 Marks)
- (b) Sketch a diagram showing components of IEEE 802.11 architecture. Briefly describe each. (8 Marks)
- (c) List three advantages and three disadvantages of Wireless LAN (6 Marks)
- (d) Describe briefly "Backhaul" and "Last mile" as applicable to WMAN (4 Marks)
- (e) List the benefits of WMANs.
Explanation is not required. (2 Marks)
- (f) List the characteristics of WMANs. (2 Marks)
- (Total 25 Marks)

- (4) (a) Draw an illustrative diagram of a wireless sensor network. (3 Marks)
- (b) List the components of a wireless sensor network. Briefly discuss their roles. (3 Marks)
- (c) List three advantages and three disadvantages of wireless sensor network. (6 Marks)
- (d) Briefly discuss three features of Sensor MAC. (6 Marks)
- (e) Briefly discuss three limitations of Sensor MAC (7 Marks)
- (Total 25 Marks)

END OF THE QUESTION PAPER



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical & Electronics Engineering
BSc Hons (Eng) Electronics & Telecommunication Engineering
Semester 8 Resit Examination 2024

Module Code	:	EE4325
Module Title	:	Power Electronics
Date	:	8 th September 2024 / 0900-1200h
Examiners	:	Gresha Samarakkody
Time Allowed	:	3 hours

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of **four** 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 6 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. Power electronics serves as the bridge between the fields of electronics and electrical engineering.

- a) Define "Power Electronics" and write its role in bridging the fields of electronics and electrical engineering.

(3 marks)

- b) Classify the two primary types of power losses encountered in switching converters and provide a concise summary presenting their generation mechanisms and their impact on the overall system performance.

(4 marks)

- c) Explain the importance of rectification in power systems.

(3 marks)

- d) Define and analyze the working of full-wave center-tapped rectifier and full-wave bridge rectifier using diagrams.

(10 marks)

[Total: 20 Marks]

Q2. Effective thermal management is paramount in power devices to ensure optimal performance, longevity, and reliability.

- a) Defend the above statement with supportive reasons.

(5 marks)

- b) Figure 1 presents an illustration of a heat sink.

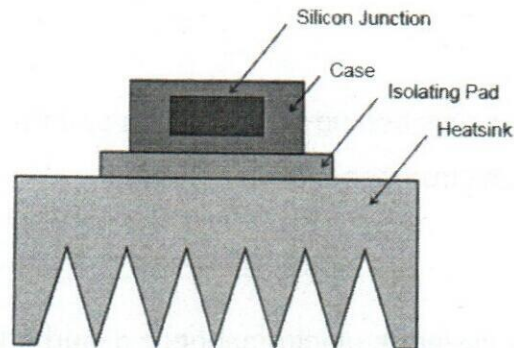


Figure 1

$$\text{Equation 1: } T_j = P_d(R_{jc} + R_{CS} + R_{SA}) + T_a$$

The equation (1) presents a formula related to the operation of the heat sink. Identify the equation and define each parameter.

(3 marks)

- c) When a diode and MOSFET are placed on the same heatsink, and only one junction from the heatsink to the ambient is present, modify equation (1) for this heatsink and define the variables.

(3 marks)

- d) When the ambient temperature is 25°C and the junction temperatures are 100°C, as specified in the datasheet with junction-to-case resistances of 1.5°C/W for the diode and 1°C/W for the MOSFETs. The case-to-heatsink resistance varies depending on the mounting method, typically ranging from 0.5°C/W to 0.8°C/W when mounted with heatsink compound. Calculate the resistance value of the heatsink to ambient at junction temperatures of 100°C, and 150°C while it is mounted with heatsink compound. Present the assumptions made at the progress of the calculation.

(9 marks)

[Total: 20 Marks]

Q3.

a) Explain the interference coupling process using a suitable diagram.

(7 marks)

b) Discuss about electromagnetic coupling between stages within the same system using a suitable diagram.

(8 marks)

c) Elaborate on the principles behind the operation of a Faraday Cage and its effectiveness in shielding against electromagnetic interference.

(7 marks)

d) "Equipment shall not generate electromagnetic disturbances exceeding a level allowing radio and telecommunication equipment and other apparatus to operate as intended".

Discuss the validity of above statement.

(4 marks)

e) "Equipment shall have an adequate level of intrinsic immunity from electromagnetic disturbances". Discuss the validity of above statement.

(4 marks)

[Total: 30 Marks]

Q4.

The rotation of a coil in a uniform magnetic field induces a voltage that varies as the cosine of the phase angle. Consider a coil consisting of 150 turns of copper wire with an area of 25 cm^2 .

- a) Determine the peak magnitude of the sinusoidal voltage produced across the terminals of this coil if it rotates within a magnetic field of 300 mT at a rate of 150 r.p.m.
(6 marks)
- b) A six-pole alternator is required to operate at 50 Hz. What is the required rotation speed?
(6 marks)
- c) What is the speed of rotation of a six-pole synchronous motor when used with a single-phase 60 Hz supply?
(6 marks)
- d) Describe the principle behind the operation of a brushless DC motor and provide an example of its application in modern technology.
(6 marks)
- e) Describe the principle behind the operation of a universal motor and provide an example of its application in modern technology.
(6 marks)

[Total: 30 Marks]

END OF THE EXAMINATION PAPER

Supportive Equations:

$$V = N \frac{d\Phi}{dt} = NBA \frac{d(\sin\theta)}{dt} = NBA\omega \cos\theta$$



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Semester 3 Re Sit Final Examination 2024

Module Code	:	EE2316
Module Title	:	Signals and Systems
Date	:	26 th August 2024
Examiners	:	Ms. Dushani Munasinghe
Time Allowed	:	0900-1200h; 3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of four (04) 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 seven (07) 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.
- You may use additional data provided at the end of this examination paper

1. (a) Consider the two discrete-time (DT) signals given Figure 1(a).

15 marks

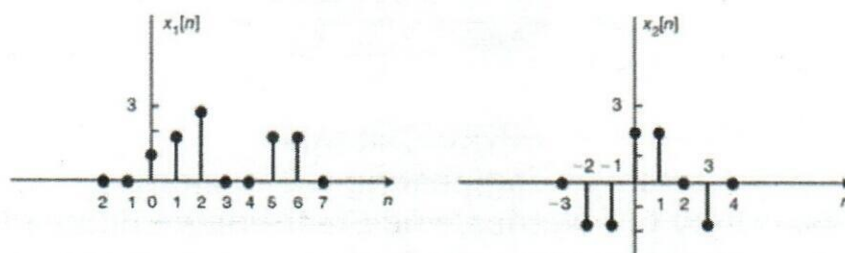


Figure 1(a)

- Write expressions for the signals, $x_1[n]$ and $x_2[n]$ using weighted and time shifted unit impulse functions i.e., $a\delta[n - k]$.
- Sketch and label the following sequences, $y_1[n]$ and $y_2[n]$ by considering the two DT signals given in Figure 1(a).

$$y_1[n] = x_1[n + 1]x_2[n - 2]$$

$$y_2[n] = u[n - 1]y_1[n]$$

- (b) Consider the continuous-time (CT) signal given in Figure 1(b).

10 marks

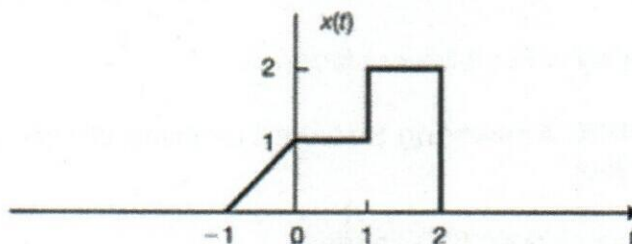


Figure 1(b)

Sketch and label the following signals by considering $x(t)$ given in Figure 1(b).

$$y_1(t) = x(t)\delta(t - 2)$$

$$y_2(t) = x(t)[u(t) - u(t - 1)]$$

2. (a) A system can be characterized by considering the linearity, time invariance, stability, causality, memory. 12 marks
- Briefly explain the requirements of a system to be,
 - Linear
 - Time invariant
 - Causal
 - Memoryless
 - State whether the system shown in Figure 2(a) is *linear, time invariant, causal, memoryless* or not. (proof should be included)

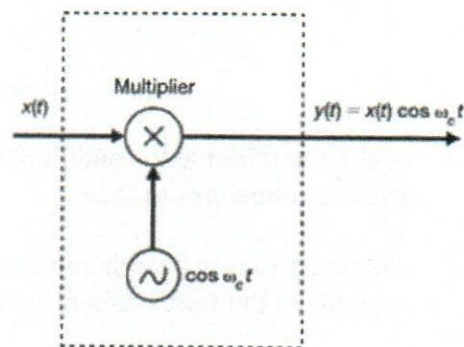


Figure 2(a)

- (b) The impulse response, $h[n]$ of a LTI system is $h[n] = \{1, 1, 1, 1, 1\}$. 13 marks

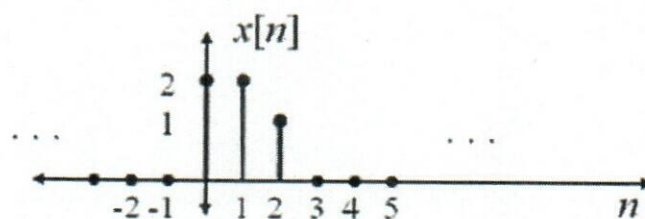


Figure 2(b)

- Use convolution (*graphical method*) to obtain the output, $y[n]$ from the LTI system.
- Verify your answer by using the *tabular method*.

3. (a) Find the Fourier coefficients and give the trigonometric Fourier series of the piecewise continuous periodic function, $x_1(t)$ given in Figure 3(a) up to **first five** terms. (Time period $T_0 = 2$ seconds, amplitude is $2A$ where $A = 1$) 10 marks

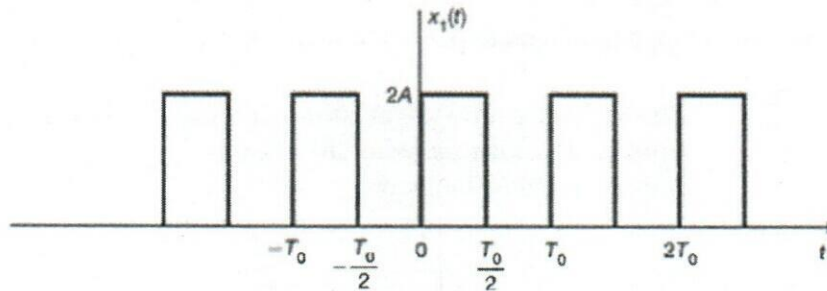


Figure 3(a)

- (b) 15 marks
- i. Give the Dirichlet's conditions that should be satisfied for the Fourier transform to exist.
 - ii. State the Parseval's relation for the energy content present in a signal $x(t)$ in time domain and in frequency domain.
 - iii. If $x(t) = e^{3t}u(-t)$ and $h(t) = e^{-3t}u(t) + 2e^t u(-t)$, find the output of the system, $y(t)$ using Fourier transforms.

(Hint: use the convolution property of Fourier transforms and the inverse Fourier transform to obtain the answer)

4. (a) Laplace transform converts a function with real variables into a function with complex variables and is the generalized form of the Fourier transform. 15 marks

i. Find the Laplace transform of $x(t) = e^{-2t}u(t) + e^{-3t}u(-t)$ and draw the pole-zero plot with the ROC.

ii. Find the inverse Laplace transform of the following,

$$H(s) = 2 - \frac{6}{s+3} ; \operatorname{Re}(s) > -3$$

iii. The output $y(t)$ of a continuous-time LTI system is found to be $2e^{-3t}u(t)$ when the input $x(t)$ is $u(t)$. Find the impulse response $h(t)$ of the system using Laplace transforms.

- (b) i. A discrete time signal is given by, 10 marks

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

Write the Z-transform of $x[n]$

- ii. A difference equation of constant coefficients is given by,

$$3y[n] - 4y[n-1] + y[n-2] = x[n]$$

Determine the system transfer function $H(z)$ and by taking inverse Z-transform, obtain the impulse response $h[n]$.

End of Question Paper

Formula Sheet

Trigonometric Fourier series coefficients

$$a_0 = \frac{1}{T_0} \int_{-T_0/2}^{+T_0/2} x(t) dt \quad a_n = \frac{2}{T_0} \int_{-T_0/2}^{+T_0/2} x(t) \cos(n\omega_0 t) dt, \quad n = 1, 2, \dots \quad b_n = \frac{2}{T_0} \int_{-T_0/2}^{+T_0/2} x(t) \sin(n\omega_0 t) dt, \quad n = 1, 2, \dots$$

Fourier transforms

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

Laplace Transforms

$$F(s) = \int_0^{\infty} f(t) \cdot e^{-st} \cdot dt$$

Z-transforms

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

Table of Laplace transform pairs

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

Table of z-transform pairs

Sequence $x[n]$	z-Transform $X(z)$	ROC
$\delta[n]$	1	All z
$u[n]$	$\frac{1}{1-z^{-1}}$	$ z > 1$
$a^n u[n]$	$\frac{1}{1-az^{-1}}$	$ z > a $
$na^n u[n]$	$\frac{az^{-1}}{(1-az^{-1})^2}$	$ z > a $
$-a^n u[-n-1]$	$\frac{1}{1-az^{-1}}$	$ z < a $
$-na^n u[-n-1]$	$\frac{1}{(1-az^{-1})^2}$	$ z < a $
$(\cos \omega_0 n) u[n]$	$\frac{1-z^{-1} \cos \omega_0}{1-2z^{-1} \cos \omega_0 + z^{-2}}$	$ z > 1$
$(\sin \omega_0 n) u[n]$	$\frac{1-z^{-1} \sin \omega_0}{1-2z^{-1} \sin \omega_0 + z^{-2}}$	$ z > 1$
$(a^n \cos \omega_0 n) u[n]$	$\frac{1-z^{-1} \cos \omega_0}{1-2az^{-1} \cos \omega_0 + a^2 z^{-2}}$	$ z > a $
$(a^n \sin \omega_0 n) u[n]$	$\frac{1-z^{-1} \sin \omega_0}{1-2az^{-1} \sin \omega_0 + a^2 z^{-2}}$	$ z > a $

Table of Fourier transform pairs

Short Table of Fourier Transforms

	$g(t)$	$G(\omega)$	
1	$e^{-at}u(t)$	$\frac{1}{a + j\omega}$	$a > 0$
2	$e^{at}u(-t)$	$\frac{1}{a - j\omega}$	$a > 0$
3	$e^{-a t }$	$\frac{2a}{a^2 + \omega^2}$	$a > 0$
4	$te^{-at}u(t)$	$\frac{1}{(a + j\omega)^2}$	$a > 0$
5	$t^n e^{-at}u(t)$	$\frac{n!}{(a + j\omega)^{n+1}}$	$a > 0$
6	$\delta(t)$	1	
7	1	$2\pi\delta(\omega)$	
8	$e^{j\omega_0 t}$	$2\pi\delta(\omega - \omega_0)$	
9	$\cos \omega_0 t$	$\pi[\delta(\omega - \omega_0) + \delta(\omega + \omega_0)]$	
10	$\sin \omega_0 t$	$j\pi[\delta(\omega + \omega_0) - \delta(\omega - \omega_0)]$	
11	$u(t)$	$\pi\delta(\omega) + \frac{1}{j\omega}$	
12	$\text{sgn } t$	$\frac{2}{j\omega}$	
13	$\cos \omega_0 t u(t)$	$\frac{\pi}{2}[\delta(\omega - \omega_0) + \delta(\omega + \omega_0)] + \frac{j\omega}{\omega_0^2 - \omega^2}$	
14	$\sin \omega_0 t u(t)$	$\frac{\pi}{2j}[\delta(\omega - \omega_0) - \delta(\omega + \omega_0)] + \frac{\omega_0}{\omega_0^2 - \omega^2}$	
15	$e^{-at} \sin \omega_0 t u(t)$	$\frac{\omega_0}{(a + j\omega)^2 + \omega_0^2}$	$a > 0$
16	$e^{-at} \cos \omega_0 t u(t)$	$\frac{a + j\omega}{(a + j\omega)^2 + \omega_0^2}$	$a > 0$
17	$\text{rect}\left(\frac{t}{\tau}\right)$	$\tau \text{sinc}\left(\frac{\omega\tau}{2}\right)$	
18	$\frac{W}{\pi} \text{sinc}(Wt)$	$\text{rect}\left(\frac{\omega}{2W}\right)$	
19	$\Delta\left(\frac{t}{\tau}\right)$	$\frac{\tau}{2} \text{sinc}^2\left(\frac{\omega\tau}{4}\right)$	
20	$\frac{W}{2\pi} \text{sinc}^2\left(\frac{Wt}{2}\right)$	$\Delta\left(\frac{\omega}{2W}\right)$	
21	$\sum_{n=-\infty}^{\infty} \delta(t - nT)$	$\omega_0 \sum_{n=-\infty}^{\infty} \delta(\omega - n\omega_0)$	$\omega_0 = \frac{2\pi}{T}$
22	$e^{-t^2/2\sigma^2}$	$\sigma\sqrt{2\pi}e^{-\sigma^2\omega^2/2}$	



CINEC Campus
Faculty of Engineering & Technology
Department of Electronics Engineering
BSc Hons (Eng) Automotive, Mechanical, Civil, Mechatronics, Electronic &
Telecommunication Engineering
Semester 3 / Re-Sit / Written Exam / 2024

Module Code	:	FE2313
Module Title	:	Engineering Profession
Date	:	22 nd Aug 2024
Examiner	:	Eng. Wipula Wimalshanthi
Time Allowed	:	03 hrs.

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of **04 descriptive type questions**. You Should Answer **ALL** questions.
- Write clearly and legibly with a blue or black pen.
- Use only the **CINEC Answering Booklet**. Additional sheets may be requested from the invigilators.
- This paper contains **03** pages.

Question 1

[20 Marks]

- 1.1) Define in your own words, who is an Engineer.
[06 Marks]
- 1.2) What are the three (03) categories of personnel who are responsible for the development and application of technology, fulfilling the needs of society?
Briefly describe the functions carried out by each category.

[14 Marks]

Question 2

[25 Marks]

- 2.1) 'Interpersonal skills' and 'Emotional Intelligence' are identified as belonging to the essential soft skills that engineers should possess. Define these terms in your own words.
[06 Marks]
- 2.2) 'Leadership' is also identified as one of the essential soft skills for Engineers. Describe in simple terms what is Leadership and state at least five (05) of the core skills of an effective Leader.
[09 Marks]
- 2.3) State at least 07 characteristics of a successful Engineer.
[10 Marks]

Question 3

[25 Marks]

- 3.1) What are the four (04) main categories of Risk? Explain with examples for each type of risk.
[06 Marks]
- 3.2) What is a Risk Register? What are the basic data that will be recorded in a typical Risk Register?
[06 Marks]
- 3.3) Why is Project Management considered important in the implementation of Engineering projects? (Write your answer in point form)
[06 Marks]
- 3.4) State at least five (05) main responsibilities of a Project Manager briefly describing each responsibility.
[07 Marks]

Question 4

[30 Marks]

4.1) Case study (1):

A factory was using a chemical in manufacturing a product. The storage tank of the chemical waste, which was hazardous to health and the environment, had a leakage. During an inspection, you as the Engineer in charge came to know about a leakage that had already taken place and that might cause an adverse impact on health and hygiene of the residents living in close proximity to the factory. You informed the Chief Engineer about the event. His reaction was to hint you that you may have to be out of the job if the case would go into the hands of social reformers.

What you would do? Discuss the possible scenarios.

[10 Marks]

4.2) Case study (2):

You have found out that senior local government managers in your civil engineering section are giving preferential treatment to their friends, equivalent to significant overpayments in consultancy payments. Discuss what action you will take and the possible consequences that you might be faced with.

[10 Marks]

4.3) Case study (3):

You have come to realize that a public procurement official, who happens to be a good friend of yours, has overpaid you for the supply of some spare parts. You as the Engineer initiated the procurement, did not realize this at the time, and you are uncomfortable that you received this kind of a favour. Discuss the action that you will be taking in this situation.

[10 Marks]



Library

Faculty of Engineering & Technology
Department of Electrical & Electronics Engineering
BSc Hons (Eng) in Mechanical Engineering / Electronic and Telecommunication
Engineering
Semester 3 – Re-sit Examination
2024 August

Module Code : EE2314
Module Title : Analogue Electronics
Date : 2024-08-24
Examiners : MGJP Fernando
Time Allowed : 3 Hrs

INSTRUCTIONS TO CANDIDATES

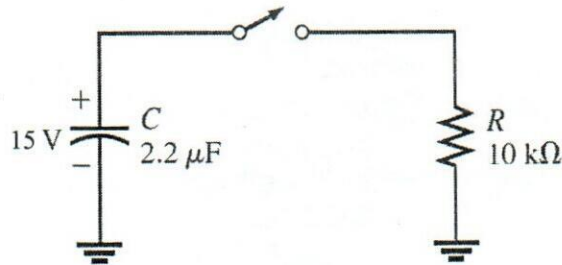
- This is a **closed book** examination.
- This paper consists of 5 questions. You Should Answer **ALL** questions.
- Write clearly legibly with a blue or black pen.
- Use only the **CINEC Answering Booklet**. Additional sheets may be requested from the invigilators.
- This paper contains 6 pages.
- Consider $V_{BE} = 0.7V$

MATERIALS REQUIRED

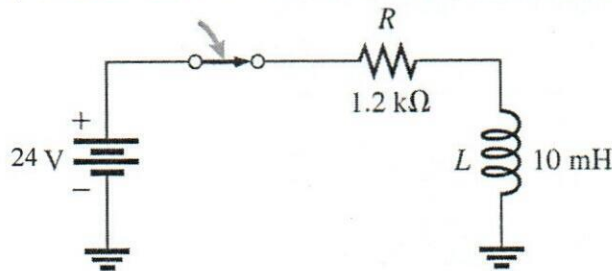
- CINEC answering Booklet; Extra answering paper
- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.

Question 01 [20 Marks]

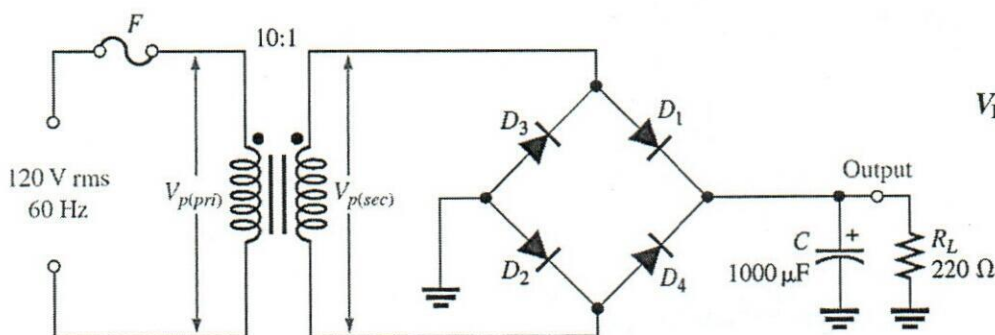
[i] Determine the capacitor voltage in **Figure 1.1** at a point in time 4 ms after the switch is closed. Draw the discharging curve.

**Figure 1.1****[06]**

[ii] Calculate the RL time constant for **Figure 1.2**. Then determine the current and the time at each time-constant interval, measured from the instant the switch is closed.

**Figure 1.2****[06]**

[iii] **Figure 1.3** shows an AC to DC converter circuit with 4 1N4001 diodes for rectification. Determine the percentage ripple for the filtered bridge rectifier when a 220 Ω load is connected.

**Figure 1.3**

$$V_{r(pp)} \cong \left(\frac{1}{fR_L C} \right) V_{p(rect)}$$

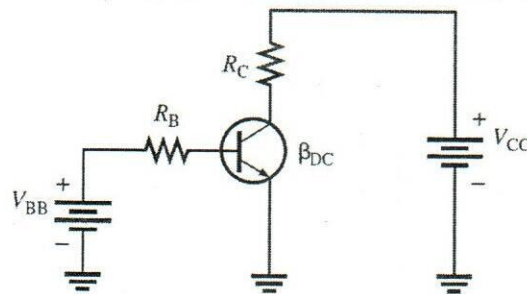
$$V_{DC} \cong \left(1 - \frac{1}{2fR_L C} \right) V_{p(rect)}$$

$$r = \frac{V_{r(pp)}}{V_{DC}}$$

[08]

Question 02 [20 Marks]

[i] Determine whether or not the transistor in **Figure 2.1** is saturated for the following values: $V_{CE(sat)} = 0.2 \text{ V}$, $\beta_{DC} = 125$, $V_{BB} = 1.5 \text{ V}$, $R_B = 6.8 \text{ k}\Omega$, $R_C = 180 \Omega$, and $V_{CC} = 12 \text{ V}$.

**Figure 2.1****[05]**

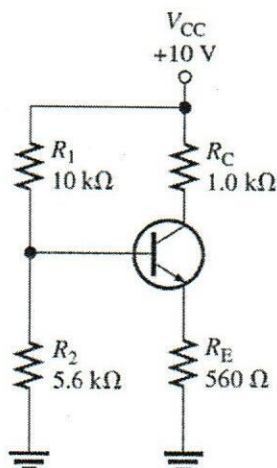
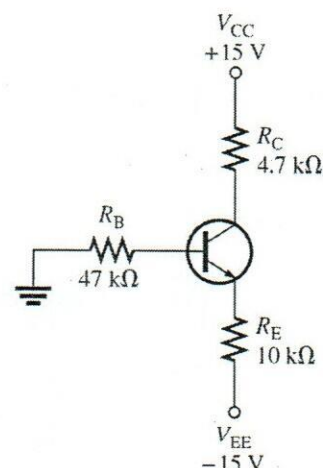
[ii] Illustrate the Base-biased, Emitter biased, Emitter-feedback biased and Collector-feedback biased BJT circuits.

[05]

[iii] Determine V_{CE} and I_C in the stiff voltage-divider biased transistor circuit of **Figure 2.2** if the gain $\beta_{DC} = 200$.

[05]

[iv] Calculate I_E and V_{CE} for the circuit given in **Figure 2.3** using the approximations $V_E \cong -1 \text{ V}$ and $I_C \cong I_E$.

[05]**Figure 2.2****Figure 2.3****Question 03 [20 Marks]**

[i] A certain cascaded amplifier arrangement has following voltage gains.

$$A_{v1} = 18, A_{v2} = 25, A_{v3} = 10 \text{ and } A_{v4} = 30$$

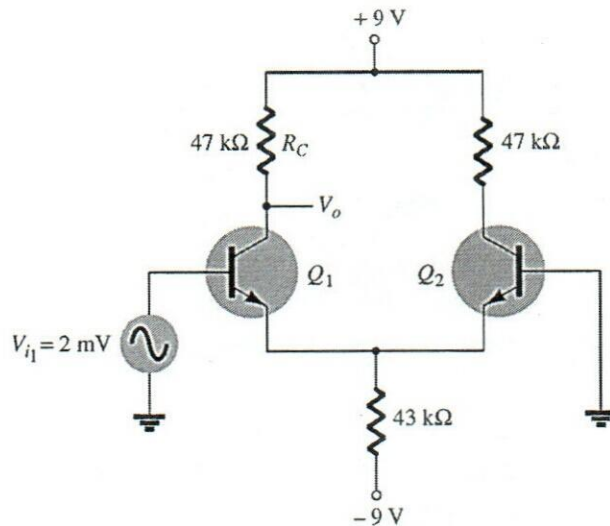
[a] Find the overall voltage gain

[b] Express each gain in decibels (dB) and determine the total voltage gain in dB

[04]

[ii] What are the 3 types of input signal configurations that can be applied to a differential amplifier?

[iii] The differential amplifier in **Figure 4.1** receives a single-ended input voltage. Calculate the output voltage V_o .



$$r_{i1} = r_{i2} = 20 \text{ k}\Omega$$

$$\beta_1 = \beta_2 = 75$$

$$I_E = \frac{V_{EE} - V_{BE}}{R_E}$$

$$I_C = \frac{I_E}{2}$$

$$v_C = v_{CC} - I_C R_C$$

$$A_v = \frac{R_C}{2r_e}$$

$$r_{i1} = r_{i2} = \beta r_e$$

$$V_o = A_v V_i$$

Figure 4.1

[iv] Explain the principle of 'Common Mode Rejection'.

[v] A differential amplifier has a differential voltage gain of 2000 and a common-mode gain of 0.6. Determine the CMRR and express it in decibels.

Question 04 [20 Marks]

[i] What are the golden rules of an op-amp?

[ii] Name 3 applications of op-amps.

[iii] Describe the operation of instrumentation amplifiers.

[iv]

[a] What is the closed-loop voltage gain of the amplifier shown in **Figure 5.1**?

[b] If a 3.3V sensor output is connected to the Op-amp input and the R_f is changed to a 47 kΩ resistor, what is the output voltage?

[v] Data sheet of the Op-amp shown in **Figure 5.2** provides the following information.

$$Z_{in} = 5 \text{ M}\Omega, Z_{out} = 23 \Omega, \text{ and } A_{ol} = 2400$$

[a] Calculate the input and output impedances.

[b] Calculate the closed loop voltage gain

$$B = \frac{R_i}{R_i + R_f}$$

$$Z_{in(NI)} = (1 + A_{ol}B)Z_{in}$$

$$Z_{out(NI)} = \frac{Z_{out}}{1 + A_{ol}B}$$

$$A_{cl(NI)} = 1 + \frac{R_f}{R_i}$$

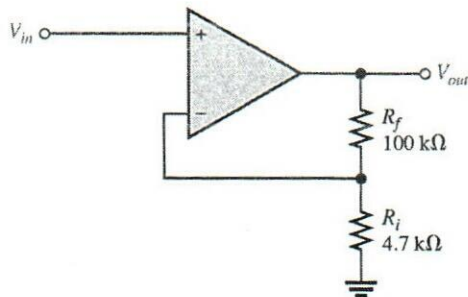


Figure 5.1

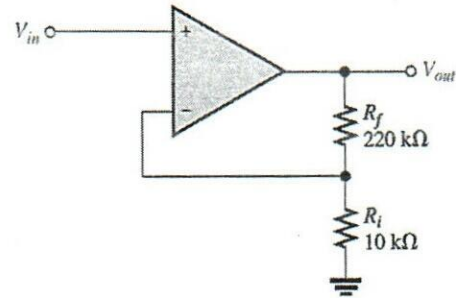


Figure 5.2

Question 05 [20 Marks]

[i] Illustrate and describe the general response curves of Low-pass, High-pass, Band-pass and Band-stop Filters.

[08]

[ii]

[a] In **Figure 5.1**, find the value of C so that X_C is approximately ten times less than R at an input frequency of 22 kHz.

[b] Assuming your answer for (a) as the nearest standard value of C , if a 10 V sine wave is applied, what are the output voltage magnitude and the phase shift?

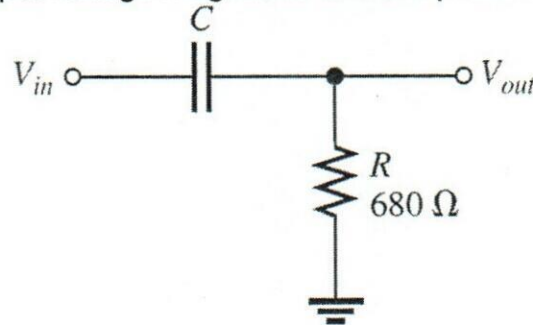


Figure 5.1

[06]

[iii] Determine the center frequency and bandwidth for the band-pass filter in **Figure 5.2** if the inductor has a winding resistance of 22 Ω.

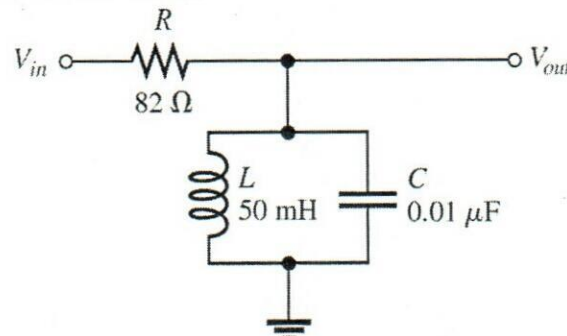


Figure 5.2

$$f_0 = \frac{\sqrt{1 - (R_W^2 C/L)}}{2\pi\sqrt{LC}}$$

$$Q = \frac{X_L}{R_W} = \frac{2\pi f_0 L}{R_W}$$

[06]

End of Paper



Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Year 4 Semester 8 Resit Final Examination 2024

Module Code	:	EE4322
Module Title	:	Microwave Engineering
Date/Time	:	11 th August 2024 / 1300-1600
Examiners	:	Srimal Punchihewa
Time Allowed	:	1300-1600; 3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- Answer **ALL** questions.
- Show all the working on the answer paper.
- Each answer to be **handwritten on CINEC Answer Booklet and CINEC Additional Answer Sheets**
- This paper contains **5** pages.

MATERIALS REQUIRED

- **CINEC Answer Booklet/Additional Answer Sheets**
- You may use a scientific calculator. This must not be programmable. This may be inspected during the examination.

Student Number

Q1. (a) Define a microwave system using an appropriate diagram

(3 marks)

(b) State the properties of scattering parameters

(4 marks)

(c) A two-port network is known to have the following scattering matrix

$$S = \begin{bmatrix} 0.15\angle 0^\circ & 0.85\angle -45^\circ \\ 0.85\angle 45^\circ & 0.20\angle 0^\circ \end{bmatrix}$$

Determine whether the above matrix is reciprocal and lossless

(6 marks)

(d) A terminated two-port network is given in Figure 1.1. Using signal flow graph and the decomposition rules derive the expression for,

(i) Γ_{in}

(ii) Γ_{out}

(12 marks)

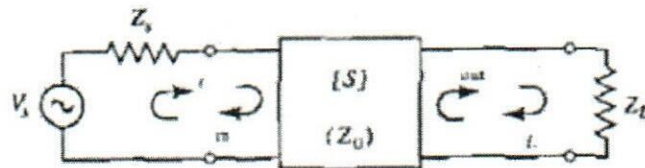


Figure 1.1

- Q2. (a) What is the difference between a PN junction diode and a Schottky barrier diode? Explain briefly the reasons for this difference in the Microwave range of frequencies.
(5 marks)
- (b) Using suitable equivalent circuit diagrams briefly explain the functioning of a PIN diode.
(5 marks)
- (c) Draw a schematic of a PIN diode phase shifter. Briefly explain its operation.
(5 marks)
- (d) Briefly explain the difference between a hetero-junction bipolar transistor (HBT) and bipolar junction transistor (BJT)
(5 marks)
- (e) Draw the cross section of an n-channel HEMT. Briefly explain the operation of the device.
(5 marks)

- Q3. (a) If V_n^+ is the amplitude of the voltage wave incident on port n , and V_n^- is the amplitude of the voltage wave reflected from port n , write down an expression for a specific element S_{ij} of the scattering matrix and briefly explain its meaning in your own words. (3 marks)
- (b) Write down the scattering matrix of an arbitrary three port network. (2 marks)
- (c) List the conditions that would make the three-port network reciprocal. What is the scattering matrix of a device satisfying such conditions. (4 marks)
- (d) If a reciprocal 3 port network is matched at all of its ports, write down its scattering matrix. (3 marks)
- (e) Name a three-port device that is matched at all of its ports and lossless. Briefly explain the functioning of two types of this device with the aid of schematic diagrams and scattering matrices. (5 marks)
- (f) Draw the schematic for an equal split three port resistive power divider. Derive its scattering matrix and show that the power divider action takes place as anticipated. (8 marks)

- Q4. (a) A $50\text{-}\Omega$ lossless transmission line is terminated in a load with impedance $Z_L = (30 - j50)\text{ }\Omega$. The wavelength is 8 cm. Find:
- (i) the reflection coefficient at the load,
 - (ii) the standing-wave ratio on the line,
 - (ii) the position of the voltage maximum nearest the load,
 - (iv) the position of the current maximum nearest the load.
- (10 marks)
- (b) Using a slotted line, the following results were obtained: distance of first minimum from the load = 4 cm; distance of second minimum from the load = 14 cm; voltage standing-wave ratio = 1.5. If the line is lossless and $Z_0 = 50\text{ }\Omega$, Find the load impedance.

(15 marks)

END OF THE QUESTION PAPER



CINEC Campus
Faculty of Engineering & Technology
Department of Electronics Engineering
BSc Hons (Eng) Automotive, Mechanical, Civil, Mechatronics, Electronic & Telecommunication Engineering
Semester 1 / Resit / Written Exam / 2024

Module Code	:	FE1316
Module Title	:	Communication & Presentation Skills
Date & Time	:	9.00am, 09 th August 2024
Examiner	:	Eng. Wipula Wimalshanthi
Time Allowed	:	03 hrs.

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 04 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 **05** pages.

Question 1

Read the following article and answer the given questions.

A Great Invention

Many great inventions are initially greeted with ridicule and disbelief. The invention of the airplane was no exception. Although many people who heard about the first powered flight on December 17, 1903 were excited and impressed, others reacted with peals of laughter. The idea of flying an aircraft was disliked by some people. Such people called Wilbur and Orville Wright, the inventors of the first flying machine, thoughtless fools. Negative reactions, however, did not stop the Wrights. Impelled by their desire to succeed, they continued their experiments in aviation.

Orville and Wilbur Wright had always had a compelling interest in aeronautics and mechanics. As young boys they earned money by making and selling kites and mechanical toys. Later, they designed a newspaper-folding machine, built a printing press, and operated a bicycle-repair shop. In 1896, when they read about the death of Otto Lilienthal, the brothers' interest in flight grew into a compulsion.

Lilienthal, a pioneer in hang-gliding, had controlled his gliders by shifting his body in the desired direction. This idea was not favoured by the Wright brothers. However, they searched for more efficient methods to control the balance of airborne vehicles. In 1900 and 1901, the Wrights tested numerous gliders and developed control techniques. The brothers' inability to obtain enough lift power for the gliders almost led them to abandon their efforts.

After further study, the Wright brothers concluded that the published tables of air pressure on curved surfaces must be wrong. They set up a wind tunnel and began a series of experiments with model wings. Because of their efforts, the old tables were repealed in time and replaced by the first reliable figures for air pressure on curved surfaces. This work, in turn, made it possible for the brothers to design a machine that would fly. In 1903 the Wrights built their first airplane, which cost less than \$1,000. They even designed and built their own source of propulsion—a lightweight gasoline engine. When they started the engine on December 17, the airplane pulsed wildly before taking off. The plane managed to stay aloft for 12 seconds, however, and it flew 120 feet.

By 1905, the Wrights had perfected the first airplane that could turn, circle, and remain airborne for half an hour at a time. Others had flown in balloons and hang gliders, but the Wright brothers were the first to build a full-size machine that could fly under its own power. As the contributors of one of the most outstanding engineering achievements in history, the Wright brothers are accurately called the fathers of aviation.

- a) What were the reactions of public when they heard about the first powered flight on Dec 17, 1903?

[3 Marks]

- b) How do you prove that Wright brothers had a strong interest in aeronautics and mechanics?

[3 Marks]

- c) What was the reason for Wright brothers' inability to obtain enough lift power for the gliders that they developed? And how did they overcome this problem?

[5 Marks]

- d) What were the improvements made to the airplane that was tested in 1905?

[4 Marks]

- e) Write a summary of the 3rd paragraph ("After further study,") using 30 to 40 words.

[10 Marks]

Question 2

Read the following Memo and answer the given questions.

MEMO

To: Theodore Gaynor, President

CC: Gail Barton, Secretary

From: James McKenna, Field Investigator

Date: 9th August 2024

Subject: SAFETY AND SECURITY OF OFFSHORE OIL-DRILLING PLATFORM #45

I have completed my investigation of the superstructure of offshore oil-drilling platform #45 as you requested. Several platforms sustained heavy damage in the August 2nd hurricane. Platform #45 is still operational, however some serious structural problems must be corrected before another storm hits the area.

The pylons anchoring the platform were subjected to severe torque in the hurricane and no longer meet current safety standards. In addition, the drilling shaft has been cracked and could shear the cable if subjected to undue pressure.

I recommend that the platform be shut down until repairs can be made. To delay them could jeopardize the lives of the 45 permanent crew members and 10 part-time workers on the rig. A major accident could also spill crude oil into the bay and destroy nearby fishing beds and beachfront.

A decision on this matter should be made as soon as possible. I realize the economic consequences of shutting down the platform and disrupting the flow of oil, however the safety considerations should be paramount. The company cannot afford a major oil spill.

I will remain on site until I hear from you. Please let me know your decision as soon as possible.

a) What is the purpose of sending this Memo?

[3 Marks]

b) What are the problems and damages to the Oil drilling platform that have been reported in this Memo?

[4 Marks]

c) What are the recommendations made by Mr. James McKenna?

[4 Marks]

d) What are the possible consequences of continuing with operations of the platform?

[4 Marks]

e) Assuming that you are the President of the Oil company, write a reply to this Memo thanking Mr. McKenna for the report, accepting the matters reported and recommendations and confirming that appropriate remedial action will be initiated.
(Use 40 to 50 words)

[10 Marks]

Question 3

- 3.1) Imagine that you have purchased a Television from ABC Company about a month ago. The warranty period offered is 02 years form the date of purchase. Now you are noticing some distortion in the picture while watching TV which is disturbing. However, the sounds seem to be unaffected. Write a formal letter to the Service Manager of ABC Company describing the fault as much as possible, mentioning the make & Model of TV, purchase references and requesting that the TV is repaired or replaced under the warranty conditions, as soon as possible.

[12 Marks]

- 3.2) You have been asked to deliver a farewell speech at the farewell ceremony of one of your engineering colleagues at your work place. Your colleague is resigning from the services of your organization after servig for a period of 10 years as a Civil Engineer. He actively took part in many major civil engineering projects undertaken by your organization during his service period and his contreibutions were commended by the administration on many occasions. He was a good team worker maintained a good relationship with every employee. He is due to leave the country soon and planning to settle overseas.

Write the farewell speech that you will be delivering.

(Use about 100 words)

[13 Marks]**Question 4**

Write an analytical essay on any national project that was completed / on-going in Sri lanka. You are required to discuss the objectives, cost, funding arrangements of the project and also whether the objectives have been achieved (in the event the project has already been completed).

(use about 150 words)

[25 Marks]



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Batch 5 Semester 4 First Sit Final Examination 2024

Module Code	:	EE2325
Module Title	:	Computer Organization
Date	:	26 th July 2024
Examiners	:	Srimal Punchihewa
Time Allowed	:	0900-1200h; 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 three (03) 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) Name the major components of a computer systems. (2 Marks)
- (b) List the major components of a processor. (3 Marks)
- (c) Briefly discuss the usage of a "System Bus" in a computer. (3 Marks)
- (d) Briefly discuss the functionality of a Microprogrammed Control Unit. (2 Marks)
- (e) Name the two internal registers used by the CPU for exchange of data with the Memory and briefly describe them. (4 Marks)
- (f) The fetched instruction is loaded into a register in the processor known as "Instruction Register". The processor interprets the instruction and performs the required action. Name the categories of this action and briefly describe them. (6 Marks)

Q2.

- (a) Though all semiconductor memory is random access, Read/Write semiconductor memory is misnamed as RAM. There are two types; Static RAM and Dynamic RAM Compare and contrast the two types. (3 Marks)
- (b) Name the Memory used to store BIOS in a computer and list its types. (3 Marks)
- (c) Discuss briefly "Refreshing" that is used in computer memory. (3 Marks)
- (d) Name a DRAM used as an Internal Memory and synchronized with an external clock. Briefly discuss it. (3 Marks)
- (e) In magnetic disks, aluminium had been used as the substrate material. Presently glass had replaced that. State the advantages of using Glass as a substrate. (4 Marks)
- (f) State the features of Winchester Hard Disk. (4 Marks)

Q3.

- (a) List the basic categories of Transfer Mode. Briefly describe them. (3 Marks)
- (b) According to original ATA standards, Programmed Input-Output Mode 0 maximum transfer rate is 3.3 MB/s.
Show that 2 bytes are transferred every 600 nanoseconds. (3 Marks)
- (c) "Despite its slowness, PIO is still around"
Briefly discuss reasons for the above. (3 Marks)
- (d) Briefly discuss First Party DMA and Third-Party DMA. (3 Marks)
- (e) Ultra DMA uses DDR and CRC.
Briefly discuss DDR and CRC (4 Marks)
- (f) There are two basic categories of hard drives which have different interfaces.
Briefly discuss them. (4 Marks)

Q4.

- (a) Sketch the Generic Model of I/O Module (4 Marks)
- (b) Sketch an External Device Block Diagram (4 Marks)
- (c) List the Major requirements or functions of an I/O module (4 Marks)
- (d) Sketch an I/O Module Diagram (4 Marks)
- (e) Briefly discuss Interrupt Driven I/O (4 Marks)

Q5.

- (a) Briefly discuss SISD, MISD, SIMD and MIMD Multiple Processor Organizations (5 Marks)
- (b) Briefly discuss the characteristics of Symmetric Multiprocessor (5 Marks)
- (c) State the several attractive features of the bus organization.
Discuss them briefly (5 Marks)
- (d) Briefly describe two basic approaches to implement Snoopy Protocols (5 Marks)

END OF THE QUESTION PAPER



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Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Electronic & Telecommunication Engineering
Semester 4 / First Sit / Final Exam / 2024

Module Code	:	EE2322
Module Title	:	Communication Systems
Date	:	24 th July 2024
Examiner	:	Eng. Wipula Wimalshanthi
Time Allowed	:	03 hrs.

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 02 Sections. **Section A** consists of **20 multiple choice questions** and **Section B** consists of **04 descriptive type questions**. You Should Answer **ALL** questions.
- Write clearly legibly with a blue or black pen.
- Use only the **CINEC Answering Booklet**. Answers to multiple choice questions shall be marked on the given **Answer Sheet**. Additional sheets may be requested from invigilators.
- This paper contains **08** pages.

MATERIALS REQUIRED

- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.

Section A**[Total of 30 Marks]**

- 1) Which one of the following is called an unguided propagation medium?
 - a) Coaxial cable
 - b) Optical Fibre
 - c) Free space
 - d) Micro strip line
- 2) L-band frequencies are predominantly used for satellite communications and Radar systems. Identify the correct wavelength belonging to L-band from the following wavelength values.
 - a) 10 m
 - b) 300 mm
 - c) 20 cm
 - d) 1 m
- 3) Scattering of microwaves in the troposphere is used in;
 - a) Radar systems
 - b) Long range navigation systems
 - c) TV broadcasting
 - d) Long distance communications
- 4) Vertical radiation patterns of Antenna systems are likely to be altered from the theoretical radiation patterns (lobing) due to;
 - a) Atmospheric absorption
 - b) Ionospheric variations
 - c) Reflections from terrain or sea
 - d) Variations in E-field polarization
- 5) If a transmission line is terminated with a load and if the load fully absorbs the power transmitted in the line, the load shall be;
 - a) Lower than characteristic impedance
 - b) Equal to the characteristic impedance
 - c) 50 ohms
 - d) Higher than characteristic impedance
- 6) Primary Radar used for air traffic control operations, cannot detect _____.
 - a) Aircraft range
 - b) Rain clouds
 - c) Aircraft altitude
 - d) Aircraft velocity
- 7) One Radar mile is denoted by;
 - a) $13.36 \mu s$
 - b) $13.26 \mu s$
 - c) $12.63 \mu s$
 - d) $12.36 \mu s$

- 8) Which one of the following microwave devices is used as high-power oscillators in Primary Radar systems?
- a) Magnetron
 - b) Klystron
 - c) Travelling Wave Tube (TWT)
 - d) Thyatron
- 9) One of the techniques used in Moving Target Indicators is;
- a) Time measurement of consecutive reflections
 - b) Self-control, patience, adaptability
 - c) Phase comparison of consecutive reflections
 - d) Pulse Repetition Frequency staggering
- 10) Secondary Surveillance Radar interrogations are on _____ and receptions are on _____
- a) 1060 MHz and 1090 MHz respectively
 - b) 1030 MHz and 1090 MHz respectively
 - c) 1090 MHz and 1030 MHz respectively
 - d) 1090 MHz and 1060 MHz respectively
- 11) How many different Codes are available for Aircraft Mode C Transponders to code the altitude information?
- a) 1,048
 - b) 4,096
 - c) 2,048
 - d) 16,384
- 12) An example of a 'Cooperative Independent Surveillance system' would be;
- a) MLAT (Multilateration)
 - b) ADS-B (Automatic Dependent Surveillance – Broadcast)
 - c) PSR (Primary Surveillance Radar)
 - d) Weather Radar
- 13) Select the true statement out of the following, regarding ADS-B system;
- a) Requires at least 03 ground stations for determining the Aircraft position
 - b) Provides only 2-D position of the Aircraft
 - c) ADS-B outages may result due to poor GPS geometry
 - d) Cost of implementing an ADS-B system and a Radar system is almost the same
- 14) GPS satellite constellation is deployed on;
- a) Low Earth Orbit (LEO)
 - b) Medium Earth Orbit (MEO)
 - c) Geostationary Earth Orbit (GEO)
 - d) An orbit above GEO

- 15) Effective Isotropic Radiated Power (EIRP) of a Satellite Earth station is 68 dBW and the antenna gain is 50 dBi. Its transmitted power would be;
- a) 18 W
 - b) 63 dBW
 - c) 63 W
 - d) 48 dBW
- 16) In a Basic Service Set (BSS) WLAN configuration, _____ is used to connect the wireless devices to the same LAN.
- a) Access point
 - b) Switch
 - c) Bridge
 - d) Router
- 17) What are the 02 TV broadcast standards which use the frame rate of 25 fps?;
- a) PAL & NTSC
 - b) SECAM & NTSC
 - c) DVB-T & DVB-C
 - d) PAL & SECAM
- 18) What is the incorrect statement out of the following?
- a) Interlaced scanning is used to save the bandwidth of TV transmission
 - b) Progressive scanning constantly flickers the whole picture several times a second
 - c) VHF is more favourable for TV broadcasting than UHF, since the effect of noise on VHF is less than UHF.
 - d) Bandwidth of combined Video and Audio signal in NTSC standard is 6 MHz.
- 19) In order to ensure guided propagation of light waves through an optical fibre with refractive indices of core and cladding are n_1 and n_2 respectively, which one of the following conditions shall be fulfilled?
- a) $n_1 > n_2$
 - b) $n_1 = n_2$
 - c) $n_1 < n_2$
 - d) None of the above
- 20) Which one of the following ranges of wavelengths are typically used for optical fibre communications?
- a) 200 – 300 nm
 - b) 300 – 400 nm)
 - c) 1800 – 6000 nm
 - d) 800 – 1600 nm

Section B

[Total of 70 Marks]

Question 1

[15 Marks]

- 1.1) What are the 02 types of propagation methods governing signal propagation? Indicate examples of media used in each method.

[03 Marks]

- 1.2) Calculate the line parameters of a Two-wire Air line with its wires separated by a distance of 1cm (D) and each wire is of 2mm in diameter (d). Wires are assumed to be perfect conductors.

Permeability of air (μ_0) = $4\pi \times 10^{-7}$ H/m, permittivity of air (ϵ_0) = 8.85×10^{-12} F/m
State your assumptions.

Relevant line parameter formulas are;

$$R' = \frac{2.R_s}{\pi.d} \Omega/m \quad (1.2.1)$$

$$G' = \frac{\pi.\sigma}{\ln\left[\left(\frac{D}{d}\right) + \sqrt{\left(\frac{D}{d}\right)^2 - 1}\right]} S/m \quad (1.2.2)$$

$$L' = \frac{\mu}{\pi} \ln\left[\left(\frac{D}{d}\right) + \sqrt{\left(\frac{D}{d}\right)^2 - 1}\right] H/m \quad (1.2.3)$$

$$C' = \frac{\pi.\epsilon}{\ln\left[\left(\frac{D}{d}\right) + \sqrt{\left(\frac{D}{d}\right)^2 - 1}\right]} F/m \quad (1.2.4)$$

[06 Marks]

- 1.3) A piece of RG-59B/U coaxial cable has a 75Ω characteristic impedance (Z_0) and effective shunt capacitance (C') of 69 pF/m. What is the effective series inductance (L') per meter? If the diameter of the inner conductor (d) is 0.584mm, and the dielectric constant of the insulation (k) is 2.23, what is the outer conductor diameter?

$$k = \frac{\epsilon}{\epsilon_0} \quad (1.3.1)$$

where, ϵ = permittivity of the insulation material and ϵ_0 = permittivity of free space

$$\text{At radio frequencies, characteristic impedance will be, } Z_0 = \sqrt{\frac{L'}{C'}} \quad (1.3.2)$$

For coaxial lines, characteristic impedance can also be represented as,

$$Z_0 = \frac{138}{\sqrt{k}} \log \frac{D}{d} \quad (1.3.3)$$

[06 Marks]

Question 2

[15 Marks]

- 2.1) Illustrate the elements of a generic Communication System using an appropriate block diagram. Briefly explain the function of each element giving examples.

[04 Marks]

- 2.2) What are the 03 main propagation modes of signals? Illustrate examples of these modes with an appropriate diagram.

[03 Marks]

- 2.3) Using an appropriate sketch explain what is meant by the Fresnel zone.

What is the minimum clearance requirement of obstacles within the first Fresnel zone in order to ensure minimum signal fading in a terrestrial microwave communication link?

The first Fresnel zone radius can be calculated using the following equation.

$$R = \sqrt{\frac{\lambda SD}{S+D}} \quad (2.3.1)$$

where S is the distance from transmitter (in meters) and D is the distance from the receiver (in meters).

A microwave communication link is established between 02 locations which are 15km apart. Operating frequency is 6 GHz. Speed of light in free space is 3×10^8 m/s.

- (i) Calculate the 1st Fresnel zone radius at the midpoint between two locations.
- (ii) If an obstacle is penetrating the 1st Fresnel zone at this midpoint, what is the maximum allowable penetration of this obstacle?

[08 Marks]

Question 3

[20 Marks]

- 3.1) Draw a block diagram of a Primary Radar system using a single Transmit / Receive frequency and briefly describe the function of each unit.

[05 Marks]

- 3.2) In a pulsed Radar system, an echo from an aircraft is received after 0.8 ms from the time of transmitted RF pulse.

Pulse Repetition Frequency (PRF) – 450 Hz

Transmission pulse width – 2 μ s

Antenna rotation speed – 7.5 r.p.m.

- Calculate the slant range of aircraft measured from Radar antenna.
- What is the Duty cycle of Radar system as a percentage?
- If the radial velocity of aircraft is 450 km/hr, what is the distance travelled by Aircraft during a single scan of the Radar antenna?
- If the half power beamwidth of the Antenna radiation pattern is 1.8° compute the hits per target during a single scan.

[07 Marks]

- 3.3) What are the major differences between Primary Radar and Secondary Radar?
[List out the differences using a Table with PSR and SSR as column headings]

[05 Marks]

- 3.4) What are the benefits of Automatic Dependent Surveillance - Broadcast (ADS-B) system compared to conventional Radar systems?

[03 Marks]

Question 4

[20 Marks]

- 4.1) State at least 05 advantages of using Optical fibres as a communication medium in comparison with copper cables.

[06 Marks]

- 4.2) A fibre cable has refractive indices of Core: 1.52 and Cladding: 1.31. Calculate the numerical aperture, the acceptance angle and critical angle for this cable.

Numerical aperture (NA) is given by;

$$NA = n \sin \theta_A = \sqrt{(n_1^2 - n_2^2)} \quad (4.2.1)$$

where; θ_A = Acceptance angle,

n_1 = Refractive index of core, n_2 = Refractive index of cladding,

n = Refractive index of air

[07 Marks]

- 4.3) Define the 'Inclination Angle' and 'Elevation Angle' of satellites using suitable diagrams.

For a satellite deployed in a stable circular orbit, following equation can be derived.

$$r = \left[\frac{gR^2}{(2\pi f)^2} \right]^{\frac{1}{3}} \quad (4.3.1)$$

Where,

R = radius of the earth (6,370 km)

r = distance between the satellite and the centre of the earth

g = the acceleration of gravity (9.81 ms^{-2})

$\omega = 2\pi f$, the angular velocity of the satellite (radians /sec)

Calculate the angular velocity of a satellite orbiting the earth at an altitude of 1,500 km from the surface of earth.

[07 Marks]

24 JUL 2024

Answer Recording Sheet

Student ID:

00013

Section A

Module Code : EE2322
Module Title : Communication Systems
Date : 24th July 2024
Examiner : Eng. Wipula Wimalshanthi
Time Allowed : 03 hrs.

Question No.	Answers			
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)
8.	a)	b)	c)	d)
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)
16.	a)	b)	c)	d)
17.	a)	b)	c)	d)
18.	a)	b)	c)	d)
19.	a)	b)	c)	d)
20.	a)	b)	c)	d)



CINEC Campus
Faculty of Engineering and Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Semester 04 First-Sit Examination 2024

Module Code : EE2326
Module Title : Analogue Circuit Design
Date : 22nd July 2024
Examiners : Mr. Randeera Liyanage
Time Allowed : 9.00AM – 12.00AM; 03hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- 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.
- 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 08 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.
- MCQ answer sheet. (Attached in Annex I)
- Log linear sheet. (Attached in Annex II)

PART A - MCQ**Instructions**

- You are required to answer all 15 MCQ questions given below.
- 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.

1. Which of the following statements accurately describes the advantages and disadvantages of analog and digital circuit design?
 - (a) Analog circuits offer high precision and accuracy, while digital circuits are susceptible to noise and interference.
 - (b) Analog circuits are robust against noise and interference, while digital circuits have limited precision.
 - (c) Analog circuits have a slower response time compared to digital circuits, while digital circuits offer smooth transitions.
 - (d) Analog circuits are suitable for understanding natural phenomena, while digital circuits excel in processing and manipulation of discrete signals.
2. In a miniaturized analog circuit design where power consumption is a critical concern, which combination of techniques would be MOST effective?
 - (a) Utilizing high-power components, voltage regulation, and power gating for unused circuit blocks.
 - (b) Employing low-power component selection, power management ICs, and efficient circuit topologies.
 - (c) Focusing solely on power gating and using high-performance components for optimal functionality.
 - (d) Implementing voltage regulation without considering component selection or circuit topology efficiency.
3. An analog circuit is experiencing significant signal distortion due to harmonic and inter-modulation effects. Which of the following design considerations is MOST likely to be the root cause?
 - (a) Improper selection of the operating point and biasing techniques.
 - (b) Inadequate filtering of high-frequency noise in the circuit.
 - (c) Insufficient thermal management leading to component overheating.
 - (d) Overemphasis on miniaturization without considering component parasitics.
4. Which of the following is NOT a primary consideration during the schematic capture phase of PCB design?
 - (a) Selecting components based on their functionality and specifications.
 - (b) Defining the logical connections between components using standardized symbols.
 - (c) Routing traces between components to optimize signal integrity.
 - (d) Ensuring the schematic accurately represents the intended circuit behavior.

5. A PCB designer is working on a high-frequency application where signal integrity is critical. Which of the following design considerations would be MOST important to address?
- (a) Selecting the cheapest substrate material to reduce manufacturing costs.
 - (b) Maximizing the number of layers in the PCB to accommodate more components.
 - (c) Minimizing trace lengths and controlling impedance to reduce signal reflections and crosstalk.
 - (d) Prioritizing the use of through-hole components for their robustness and ease of assembly.
6. In high-frequency circuit design, which of the following components is MOST likely to exhibit a self-resonant frequency where it transitions from behaving primarily as an inductor to behaving primarily as a capacitor?
- (a) Resistor
 - (b) Capacitor
 - (c) Inductor
 - (d) Transistor
7. Which of the following statements about passive filters is INCORRECT?
- (a) Passive filters use components like resistors, capacitors, and inductors.
 - (b) They can be classified as low-pass, high-pass, band-pass, or band-stop filters.
 - (c) Passive filters typically have a higher power consumption compared to active filters.
 - (d) They do not require an external power source to operate.
8. 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) Passing frequencies within a specific range and attenuating the frequencies outside the range.
 - (d) Attenuating frequencies within a specific range and passing the frequencies outside the range.
9. You are tasked with designing a fourth-order low-pass active filter with a cutoff frequency of 1 kHz and a maximally flat passband response. Which of the following design approaches would be the MOST appropriate?
- (a) Implement a single fourth-order Sallen-Key topology using a single op-amp and carefully calculated component values.
 - (b) Cascade two second-order Butterworth Sallen-Key filters, each with a cutoff frequency of 1 kHz.
 - (c) Design a fourth-order Chebyshev filter with a ripple of 0.5 dB to achieve a steeper roll-off.
 - (d) Employ a multiple feedback topology to minimize the number of components.

10. Consider a second-order Sallen-Key low-pass filter with unity gain. You want to modify the filter to achieve a gain of 5 while maintaining the same cutoff frequency and filter type. Which of the following modifications would be the MOST effective?
- (a) Increase the value of both resistors in the RC network that sets the cutoff frequency.
 - (b) Introduce a voltage divider network at the input of the op-amp.
 - (c) Add a non-inverting amplifier stage with a gain of 5 after the Sallen-Key filter.
 - (d) Replace the unity-gain Sallen-Key topology with a multiple feedback topology designed for a gain of 5.
11. You are tasked with simulating the behaviour of a circuit containing both linear and nonlinear components over time for a wide range of input frequencies and amplitudes. Which of the following simulation methods would be MOST suitable for this task?
- (a) DC Operating Point Analysis
 - (b) AC Small-Signal Analysis
 - (c) Transient Analysis with Nonlinear Device Models
 - (d) Harmonic Balance Analysis
12. While simulating a voltage amplifier circuit in SPICE, you observe that the output voltage is significantly lower than expected, even when the input voltage is within the specified range. Which of the following factors is the MOST likely cause of this discrepancy?
- (a) The power supply voltage in the simulation is set too low.
 - (b) The amplifier model in the simulation does not accurately represent the real-world device.
 - (c) The input signal frequency is outside the amplifier's bandwidth.
 - (d) The load resistance connected to the amplifier output is too high.
13. An RC circuit is subjected to a step voltage input. During the transient phase, which of the following statements BEST describes the behavior of the capacitor?
- (a) The capacitor voltage instantaneously reaches its final steady-state value.
 - (b) The capacitor current remains constant throughout the transient phase.
 - (c) The capacitor voltage exponentially increases towards its final steady-state value.
 - (d) The capacitor current exponentially decreases towards zero.

14. Which of the following is NOT a primary goal of reverse engineering a printed circuit board (PCB)?
- (a) Generating fabrication data for a new PCB with identical functionality.
 - (b) Replicating the exact functionality of an existing PCB.
 - (c) Identifying and replacing faulty components on a PCB.
 - (d) Designing a new PCB with improved functionality compared to the original.
15. You are troubleshooting a digital circuit and suspect a node is stuck in a specific logic state. Which mode on your logic probe would be MOST helpful in confirming this suspicion?
- (a) Pulse Mode
 - (b) Memory Mode
 - (c) High Impedance Mode
 - (d) TTL/CMOS Mode

[Total - 30 Marks]

PART B - ESSAY**Question 01**

- (a) Briefly describe the operating principle of an analogue comparator and list three key specifications that are important to consider when selecting a comparator for a specific application. *(Use two sentences for the description and one sentence per specification.)*
(04 Marks)
- (b) Explain the concept of open-collector output in the context of the LM311 comparator and the need for a pull-up resistor when using an LM311 comparator? *(Use three sentences for the description.)*
(03 Marks)
- (c) Discuss the differences between through-hole technology (THT) and surface mount technology (SMT) in the context of analogue circuit design. *(Include at least one detailed advantage and disadvantage per technology.)*
(04 Marks)
- (d) You are tasked with designing a battery-powered temperature monitoring system for a remote industrial site. The system should use a temperature sensor with an analogue voltage output, a comparator, and a microcontroller. The microcontroller should turn on a warning LED when the temperature exceeds a certain threshold.
Discuss the design considerations you would take into account when selecting the comparator for this application with respect to comparator selection, circuit configuration, pull-up resistor selection and noise reduction. *(Use approximately 150 words.)*
(04 Marks)

[Total - 15 Marks]**Question 02**

- (a) Briefly describe the concept of noise in analog circuits and list three common sources of noise that can affect circuit performance. *(Use one sentence for the description and one sentence per each source.)*
(04 Marks)
- (b) Explain the importance of thermal management in analog circuit design, potential consequences of inadequate thermal management, and what techniques can be employed to mitigate thermal issues? *(Use three sentences for the explanation.)*
(03 Marks)
- (c) Explain the concept of transmission line effects and their significance in high-frequency circuit design. *(Use two sentences each to explain the concept and two sentences for the significance.)*
(04 Marks)

(d) You are tasked with designing a high-frequency amplifier for a wireless communication system. Discuss the key considerations you would take into account to ensure optimal performance and reliability with respect to the following aspects. (*Use one sentence per description.*)

- Component selection and circuit topology
- PCB layout and grounding strategies
- Thermal management techniques
- Noise mitigation strategies

(04 Marks)

[Total - 15 Marks]

Question 03

You are tasked with designing a first order passive low pass filter (LPF) to attenuate frequencies above 1000Hz.

(a) If a capacitor of $0.1\mu F$ is used, determine the value of the resistor required according to the E12 series.

(02 Marks)

(b) Draw the circuit diagram of the LPF, clearly labeling the input voltage (V_i), output voltage (V_o), and component values.

(02 Marks)

(c) Derive the mathematical model of the LPF in the time domain, expressing the relationship between (V_i) and (V_o) using a differential equation.

(02 Marks)

(d) Using the Laplace transform, obtain the transfer function $G(s)$ of the LPF, where s is the complex frequency variable. Substitute the corresponding parameter values and simplify.

(02 Marks)

(e) Determine the output voltage $V_o(t)$ of the LPF when a unit step input voltage $V_i(t)$ is applied at $t = 0$. Hence, sketch the time response plot of $V_o(t)$ from $t = 0s$ to $t = 0.001s$ at 0.0001s intervals.

(06 Marks)

(f) Using your answer to (e), determine the approximate time constant and rise time.

(02 Marks)

(g) Determine and plot the frequency response of the LPF (magnitude and phase) using a log-linear sheet for a frequency range of 1000 rad/s to 10000 rad/s at decade in 10 intervals. (*Your answer must include the frequency response equations, table of calculated frequency response values and the bode plot. Use the log-linear sheet given in Annex II and attach to your answer script.*)

(09 Marks)

[Total - 25 Marks]

Question 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 Marks)
- (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 Marks)
- (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 Marks)

[Total - 15 Marks]

-END OF EXAMINATION PAPER-

Reference Equations

$$i_c = C \cdot \frac{dV_c}{dt} ; f = \frac{1}{2\pi RC}$$

Laplace Transform Pairs;

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



Faculty of Engineering & Technology
Department of Electronic & Telecommunication

BSc (Hons) in Electronic & Telecommunication Engineering /Mechatronics
Engineering Mechanical Engineering /Automotive Engineering /Civil
Engineering

Re-sit Final Examination 2024

Module Code : EE1325
Module Title : Programming Fundamentals
Date/Time : 18th July 2024 / 9.00 am – 12.00 pm.
Examiners : Ms. A.M.L. Chamini
Time Allowed : 3 Hours

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination.
- The examination consists of five (05) questions in total. **You are required to answer all five (05) questions.**
- The examination is marked out of 100 points. Each question carries equal weightage, contributing 20 points to the overall score.
- Show all the working on the answer paper.
- This paper contains 3 pages.

MATERIALS REQUIRED

- A4 Booklet
- You may use a scientific calculator. This must not be programmable.

Student Number:

Question 1

- a. Describe what is a flowchart? [04 Marks]
- b. Write a pseudocode to add two numbers and display the output. [06 Marks]
- c. Draw a flowchart to display following messages using a case structure. Note that you must get the age as the input from the user.
- If age = 18 Display "You can vote"
 - If age = 39 Display "You're middle aged"
 - If age = 65 Display "Consider retirement"
 - If age is equal to anything else, display "Age is unimportant"

[10 Marks]

[Total Marks: 20 Marks]

Question 2

- a. Explain what is a comment in C programming [04 Marks]
- b. Provide the output for the following code. [06 Marks]

```
int main(){  
    double a = 7.2;  
    int b = (int) a;  
    printf("The value is: %d",b);  
    return 0;  
}
```

- c. Create a structure using C programming language to save the Book Id, name, author and number of copies of a book. [10 Marks]

[Total Marks: 20]

Question 3

- a. Convert the following code to a single statement using the conditional operator.

```
if ( age >= 18 )  
    printf( "You are an adult" );  
else  
    printf( "Still a Teenager" );
```

[04 Marks]

- b. Write a program to get a number as the user input and display whether the number is negative or positive [06 Marks]
- c. Write a C program to display the following pattern (Figure 01) using a **for loop**.

```
*  
**  
***  
****  
*****
```

Figure 01

[10 Marks]

[Total Marks: 20]

Question 4

- a. Mention two build-in functions of C. [04 Marks]
- b. Write a function called max to determine and return the largest of two integers. The integers should be input from the keyboard in the main program and pass to max function. [06 Marks]
- c. Write a C program code to define, initialize and print the elements of a two-dimensional array. [10 Marks]

[Total Marks: 20]

Question 5

- a. Briefly describe the two (02) of the coding standards [04 Marks]
- b. Declare and initialize three variables using regular and pointer variables for data types int, float and char. Then display those values using both regular and pointer variables [06 Marks]
- c. Write a C program to input the id and name of a student from the keyboard and write the data to "Marks.txt" file. [10 Marks]

[Total Marks: 20]



Faculty of Engineering & Technology
Department of Electrical and Electronic Engineering
BSc Hons (Eng) Electronic and Telecommunication/ Mechatronics/
Mechanical/ Civil/ Automotive Engineering
Batch 6 Semester 2 First Sit Examination 2024

Module Code	:	EE1325
Module Title	:	Programming Fundamentals
Date/Time	:	18th July 2024 / 0900-1200h
Examiners	:	Ms. Dushani Munasinghe
Time Allowed	:	3 Hours

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination.
- Attempt **all questions**.
- Each answer to be written in an answer booklet (provided).
- Each answer to start on a new page.
- This paper contains 6 pages

MATERIALS REQUIRED

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

Question 1

- a. Differentiate between the *syntax* and *semantics* of a programming language.

[04 Marks]

- b. Refer to the C++ program below. Identify the preprocessor directive, header file, main function, output statement and return statement (Copy down the code to the answer script and label the above).

```
#include <iostream>

using namespace std;

int main()
{
    cout << "Hello World!!!" << endl;
    return 0;
}
```

[05 Marks]

- c. i. Write the output (final value of 'num' variable) of the following program.

```
int num = 2;

num++;

num += 50;

cout << num;
```

- ii. Write a program in C++ which divides 5 by 2 and displays the output as 2.5.

[04 marks]

- d. Draw a flowchart to display following messages. Note that you must obtain the age as the input from the user.

- If age = 18 Display "You can vote"
- If age = 39 Display "You're middle aged"
- If age = 65 Display "Consider retirement"
- If age is equal to anything else, display "Age is unimportant"

[07 Marks]

[Total Marks: 20 Marks]

Question 2

- a. Explain the significance of using conditional statements in a computer program. **[04 Marks]**

- b. Write a program in C++ to input three numbers as keyboard inputs and find the smallest out of the three to be displayed as the output.

[06 marks]

- c. Refer to the part of a computer program given below which performs the operation of a calculator written using switch cases. Note that '*oper*' stands for the operator, '*num1*' and '*num2*' stand for input numbers.

```
switch (oper) {
    case '+':
        cout << num1 << " + " << num2 << " = " << num1 + num2;
        break;
    case '-':
        cout << num1 << " - " << num2 << " = " << num1 - num2;
        break;
    case '*':
        cout << num1 << " * " << num2 << " = " << num1 * num2;
        break;
    case '/':
        cout << num1 << " / " << num2 << " = " << num1 / num2;
        break;
```

- i. Explain the working of the above code segment in your own words.
 ii. Modify the code to display a warning message if a wrong character is entered as an input operator.

[05 marks]

- d. Write a program in C++ to display the following pattern.

```
5 4 3 2 1
5 4 3 2
5 4 3
5 4
5
```

[05 Marks]**[Total Marks: 20 Marks]**

Question 3

- a. Function is a callable unit in a computer program that can be invoked multiple times when necessary.
- State two (02) advantages of using functions in computer programming.
 - Differentiate between in-built functions and user-defined functions with examples.

[04 Marks]

- b. Write a function called '*fact()*' to calculate the factorial of a number given as a keyboard input and demonstrate how the function '*fact()*' can be called/invoked in the *main()* program.

[08 marks]

- c. Write a C++ program to define, initialize and print the elements of a two-dimensional array.

[08marks]**[Total Marks: 20 Marks]**

Question 4

- a. Pointers are variables that store memory addresses. Explain what is '*pointer dereferencing*' in your own words.

[04 marks]

- b. Declare and initialize three variables using regular and pointer variables for datatypes *int*, *float* and *char*. Then show how the values of these variables can be displayed using both regular and pointer variables.

[06 marks]

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

[03 marks]

- d. Write a C++ program to write the ID and name which are given as keyboard inputs to a file named "Marks.txt". (In your program, lines of code should be written to enter the data as keyboard inputs, create and open the file, write data into the file and close the file)

[07 marks]

[Total Marks: 20 Marks]

Question 5

- a. Exception handling is the process of responding to occurrence of exceptions.
List three (03) exceptions that require specific handling in computer programs.

[03 marks]

- b. Explain why a good programming style is required when writing a code in any programming language.

[05 marks]

- c. Debug the following C++ code and explain how you handle the errors. Rewrite the corrected code.

```
int n
cout >> "Number";
cin << n;

for (int i = 0, i <= 10, i++)

    cout >> n >> "*" >> i >> "=" >> n * i >> "\n";

return 0;
```

Hint: The error codes from the debugging tool of the compiler states the following.

- *Error1: 'int i': redefinition*
- *Error2: binary '<<':no operator found which takes a left hand operand of type 'std::istream' (or there is not acceptable conversion)*
- *Error3: binary '>>': 'std::ostream' does not define this operator or a conversion to a type acceptable to the predefined operator*
- *Error4: Local variable is not initialized*

[12 marks]

[Total Marks: 20 Marks]

-End of Examination Paper-



CINEC Campus
Faculty of Engineering and Technology
Department of Electrical and Electronics Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
BSc Hons (Eng) Mechatronics Engineering
Semester 04 First-Sit Examination 2024

Module Code : EE2323
Module Title : Electronic Design and Realization
Date : 15th July 2024
Examiners : Mr. Randeera Liyanage
Time Allowed : 1.30PM – 04.30PM; 03hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- 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.
- 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 08 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.
- MCQ answer sheet. (Attached in Annex I)

PART A - MCQ**Instructions**

- You are required to answer all 15 MCQ questions given below.
 - 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.
1. A design team is in the conceptual design phase of a new wearable fitness tracker. They are considering several different sensor technologies for heart rate monitoring, each with varying TRLs. Which of the following considerations would be MOST crucial at this stage in choosing a sensor technology?
 - (a) The specific component manufacturers available for the chosen sensor technology.
 - (b) The precise placement of the sensor within the device's housing.
 - (c) The projected cost of the sensor at scale production volumes.
 - (d) The balance between the sensor's technical maturity (TRL) and its potential for innovation in the product.
 2. During beta testing of a new smart home security system, users report that the system frequently triggers false alarms due to motion detection sensitivity. Which of the following design flow steps would be MOST appropriate to address this feedback?
 - (a) Revisit the certification process to ensure compliance with electromagnetic interference standards.
 - (b) Conduct a new round of alpha testing with internal employees to isolate the specific cause.
 - (c) Reiterate through the design iteration phase, focusing on refining the motion detection algorithm.
 - (d) Immediately halt production and recall all beta test units to prevent further negative feedback.
 3. A PCB designer is tasked with creating a layout for a high-power amplifier circuit. Which of the following design considerations would be the MOST important to prioritize in this scenario?
 - (a) Minimizing the number of vias to reduce manufacturing costs.
 - (b) Selecting a substrate material with high thermal conductivity.
 - (c) Using the smallest possible trace widths to save space.
 - (d) Placing all components on the top layer for easier assembly.

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) Inadequate power supply decoupling.
 - (d) Minimum trace width violations.
5. An electronics engineer is designing a power supply circuit that requires a stable 5V output voltage. Which of the following voltage regulator ICs would be the MOST suitable choice for this application?
- (a) LM317
 - (b) LM1117
 - (c) LM7805
 - (d) LM393
6. A hobbyist is building a prototype circuit on a breadboard and needs to connect various components and power rails. Which combination of breadboard wires would be the MOST versatile and practical for this purpose?
- (a) Only M2M wires of various lengths
 - (b) Only F2F wires of various lengths
 - (c) A combination of M2M and F2F wires of various lengths
 - (d) A combination of M2M and F2M wires of various lengths
7. An embedded systems engineer is selecting a microcontroller for a battery-powered IoT device that needs to perform complex calculations and communicate wirelessly. Which of the following microcontroller features would be MOST crucial for this application?
- (a) Low power consumption and integrated Wi-Fi/Bluetooth module.
 - (b) High clock speed and large on-chip ROM for storing complex algorithms.
 - (c) Large number of I/O pins and built-in analog-to-digital converter (ADC).
 - (d) Support for multiple programming languages and extensive community forums.
8. A student is starting a new electronics project and needs to choose a development platform. The project requires a microcontroller with integrated Wi-Fi, ample processing power, and a user-friendly programming environment. Which of the following development boards would be the MOST suitable choice?
- (a) Arduino Uno
 - (b) Raspberry Pi Pico
 - (c) ESP32 DevKit
 - (d) STM32 Nucleo

9. An engineer is designing an ergonomic handheld device with complex curves and organic shapes. Which 3D modeling technique would be MOST suitable for creating the initial enclosure design?
- (a) Parametric modeling
 - (b) Surface modeling
 - (c) Assembly modeling
 - (d) Boolean modeling
10. During the enclosure design process, an engineer has created a 3D model and wants to quickly assess its form, fit, and function before moving to mass production. Which of the following methods would be the MOST efficient and cost-effective way to achieve this?
- (a) Injection molding
 - (b) CNC machining
 - (c) 3D printing
 - (d) Vacuum forming
11. An electronics manufacturer is experiencing a high rate of product failures in the field due to electrostatic discharge (ESD). Which of the following quality assurance measures would be the MOST effective in addressing this issue?
- (a) Implementing automated optical inspection (AOI) during PCB assembly.
 - (b) Conducting a design review to optimize component placement and spacing.
 - (c) Implementing ESD control procedures in manufacturing and handling processes.
 - (d) Performing accelerated life testing (ALT) on a sample of finished products.
12. A new electronic product is nearing the end of its development cycle. Which of the following testing methods would be MOST suitable for assessing the product's reliability and identifying potential design flaws before mass production?
- (a) Functional testing
 - (b) In-circuit testing (ICT)
 - (c) Highly accelerated life testing (HALT)
 - (d) Environmental stress screening (ESS)
13. An electronics design team is working on a complex project involving multiple engineers and technicians. Which type of documentation would be MOST crucial for ensuring effective collaboration and minimizing misunderstandings among team members?
- (a) Project proposal
 - (b) Requirements specification
 - (c) Test plans and reports
 - (d) User manuals and guides

14. An embedded systems developer is working on a project that requires real-time data processing with strict timing constraints. Which of the following programming languages would be the MOST suitable for this application?
- (a) Python
 - (b) Java
 - (c) C++
 - (d) C
15. A real-time operating system (RTOS) is being used to manage tasks in an industrial control system. Which of the following scheduling algorithms would be MOST appropriate to ensure that high-priority tasks are always executed promptly?
- (a) Round-robin scheduling
 - (b) First-come-first-served (FCFS) scheduling
 - (c) Preemptive priority scheduling
 - (d) Shortest job first (SJF) scheduling

[Total - 30 Marks]

PART B - ESSAY**Question 01**

- (a) Briefly list the seven (7) main stages of the electronic product design flow. *(Use one sentence per each stage.)*
(03 Marks)
- (b) Describe what real-time considerations are in the context of electronic design. *(Use two sentences for the description.)*
(02 Marks)
- (c) Explain how real-time considerations can influence decisions made during the detailed design phase of an electronic product, particularly when it comes to PCB prototyping. *(Use four detailed sentences for the description.)*
(04 Marks)
- (d) You are leading a team to design a new industrial robot controller that requires real-time responsiveness. Discuss how you would incorporate real-time considerations throughout the electronic product design flow, from concept to prototype, to ensure the final product meets the stringent timing requirements. *(Use six detailed sentences.)*
(06 Marks)

[Total - 15 Marks]**Question 02**

- (a) Briefly list three essential components of a microcontroller and describe their functions. *(Use one sentence per each process.)*
(03 Marks)
- (b) List and describe the four main components of IoT enabled devices. *(Use one sentence per each process.)*
(02 Marks)
- (c) Explain the role of microcontrollers and development platforms in electronic design, highlighting their key advantages. *(Use two sentences for the explanation and three bullet points each with one sentence for the advantages)*
(04 Marks)
- (d) Explain the IoT development cycle, outlining the key stages involved from ideation to deployment. *(Use not more than eight bullet points for the explanation.)*
(04 Marks)
- (e) You are tasked with developing an IoT-based smart irrigation system for a large agricultural farm. The system needs to monitor soil moisture, weather conditions, and crop health, and automatically control the irrigation schedule to optimize water usage. Discuss the role of microcontrollers, development platforms, and IoT technologies in the design and implementation of this system. *(Use approximately 200 words.)*
(07 Marks)

[Total - 20 Marks]

Question 03

- (a) Briefly describe the three main manufacturing processes used in creating electronic product enclosures: 3D printing, injection molding, and CNC machining. *(Use one sentence per each process.)*
(03 Marks)
- (b) Explain the key differences between 3D printing and injection molding with respect to cost, speed, design flexibility and surface finish in the context of prototyping electronic enclosures. *(Use a table with columns for 3D printing and injection molding against 4 specific features.)*
(04 Marks)
- (c) Compare and contrast CNC machining and injection molding in terms of material selection, precision, surface finish, and their relevance in electronic product enclosure design. *((Use a table with columns for CNC machining and injection molding against 4 specific features.))*
(04 Marks)
- (d) You are leading the design team for a new portable medical device. The enclosure needs to be lightweight, durable, have a smooth, aesthetically pleasing finish, and be produced in large quantities. Discuss the factors you would consider in choosing between 3D printing, injection molding, and CNC machining for the enclosure's production. *(Use approximately 250 words for the answer.)*
(09 Marks)

[Total - 20 Marks]

Question 04

- (a) Briefly list three essential types of tests performed during electronic design testing and quality assurance. *(Use one sentence per each type.)*
(03 Marks)
- (b) Describe the purpose and importance of a design specification document in electronic design. *(Use not more than two sentences for the description.)*
(02 Marks)
- (c) Explain how proper documentation practices can contribute to successful electronic design testing and quality assurance. *(Use not more than four sentences for the explanation.)*
(04 Marks)
- (d) Discuss the significance of environmental testing and reliability testing in ensuring the long-term performance and customer satisfaction of electronic products. *(Use not more than six sentences.)*
(06 Marks)

[Total - 15 Marks]

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15. III 7/174

ANNEX I - MCQ ANSWER SHEET

CINEC

Student ID:.....

Instructions - 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)
8. (A) (B) (C) (D)
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 & Electronic Engineering
BSc Hons (Eng) Electronic and Telecommunication Engineering
Year 4 Semester 8 First Sit Final Examination 2024

Module Code : EE4322
Module Title : Microwave Engineering
Date/Time : 11th May 2024 / 0900-1200
Examiners : Srimal Punchihewa
Time Allowed : 0900-1200; 3 hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- Answer **ALL** questions.
- Show all the working on the answer paper.
- Each answer to be **handwritten on CINEC Answer Booklet** and **CINEC Additional Answer Sheets**
- This paper contains 3 pages.

MATERIALS REQUIRED

- **CINEC Answer Booklet/Additional Answer Sheets**
- You may use a scientific calculator. This must not be programmable. This may be inspected during the examination.
- Attach Smith Chart along with the solution.

Student Number

- Q1. (a) State the differences between two-cavity and multi-cavity Klystron amplifiers. What is velocity modulation and how does it take place?
(6 marks)
- (b) What is the purpose of the slow wave structures used in Travelling Wave Tube amplifiers?
(5 marks)
- (c) A 2cm (0.02m) diameter helix has a pitch of 1 cm (0.01m). Find
(i) the phase velocity
(ii) the percentage of the speed of light represented by the slower phase velocity
(5 marks)
- (d) Compare Travelling Wave Tube and Klystron amplifier considering the main features of each of them.
(4 marks)
- (e) Explain what is negative resistance and how it occurs in a Gunn diode.
(5 marks)
- Q2. (a) What is the difference between a normal pn diode and a Schottky barrier diode? Explain briefly the reasons for this difference in the Microwave range of frequencies.
(5 marks)
- (b) Using suitable equivalent circuit diagrams briefly explain the functioning of a PIN diode.
(5 marks)
- (c) Draw a schematic of a PIN diode phase shifter. Briefly explain its operation.
(5 marks)
- (d) Briefly explain the difference between a hetero junction bipolar transistor (HBT) and bipolar junction transistor (BJT)
(5 marks)
- (e) Draw the cross section of an n-channel HEMT. Briefly explain the operation of the device.
(5 marks)
- Q3. (a) If V_n^+ is the amplitude of the voltage wave incident on port n and V_n^- is the amplitude of the voltage wave reflected from port n, write down an expression for

a specific element S_{ij} of the scattering matrix and write down the meaning of it in words

(3 marks)

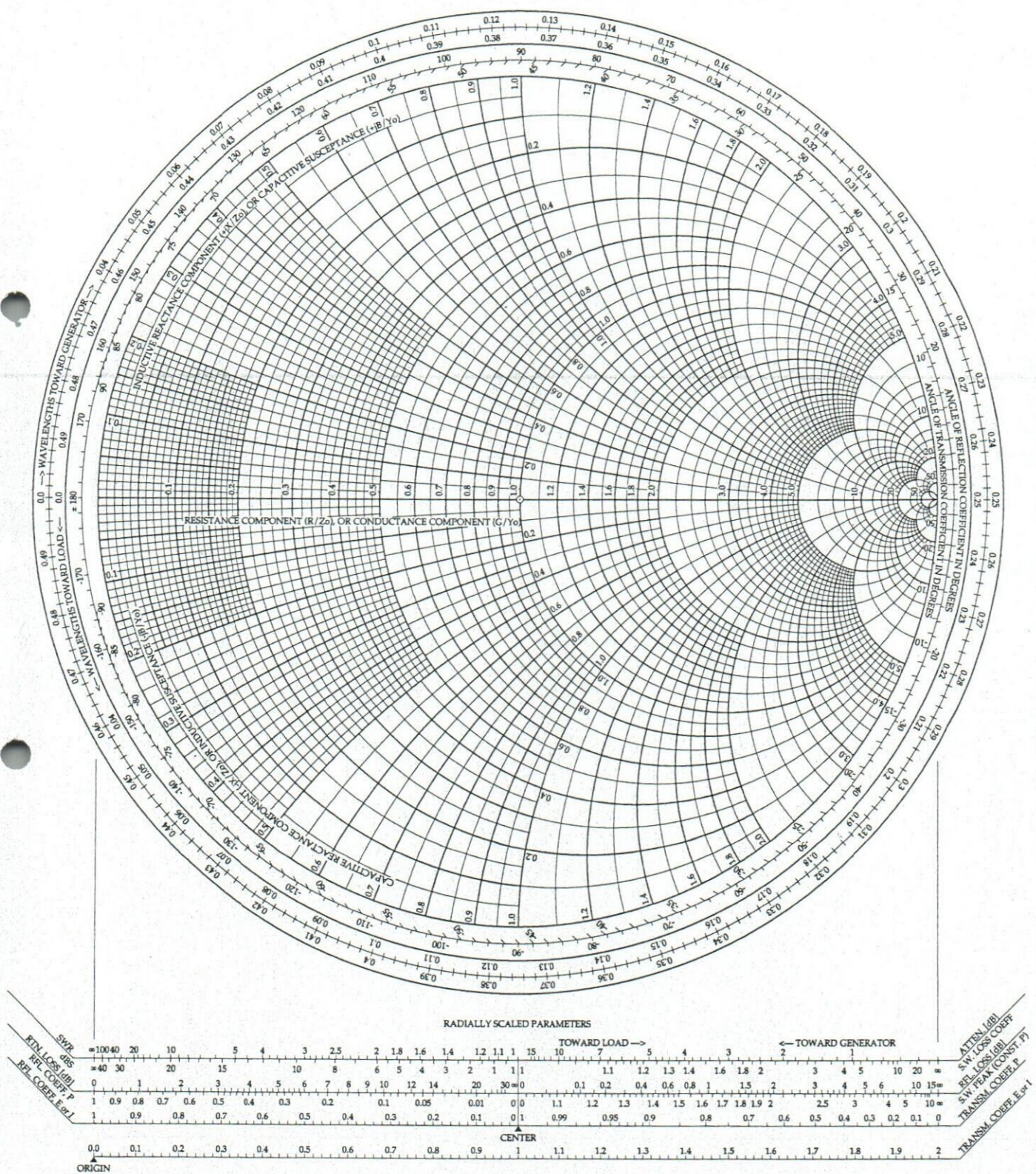
- (b) Write down the scattering matrix of an arbitrary three port network. (2 marks)
- (c) Write down the conditions that would make the three-port network reciprocal. What is the scattering matrix of a device satisfying such conditions. (4 marks)
- (d) If a reciprocal 3 port network is matched at all of its ports, write down its scattering matrix. (3 marks)
- (e) Name a three-port device that is matched at all of its ports and lossless. Briefly explain the functioning of two types of this device with the aid of schematic diagrams and scattering matrices. (5 marks)
- (f) Draw the schematic for an equal split three port resistive power divider. Derive its scattering matrix and show that the power divider action takes place as anticipated. (8 marks)
- Q4. (a) Measurements on a 50Ω slotted line gave a VSWR of 2.0 and a distance from load to first minimum of 0.2λ . Determine both the equivalent series and equivalent parallel circuits for Z_L . (10 marks)
- (b) Rework Q4(a) using the provided Smith Chart (15 marks)

library

00005

The Complete Smith Chart

Black Magic Design



$$v_p = \frac{c \rho}{\sqrt{\rho^2 + (\lambda d)^2}}$$

$$S_{ij} = \left. \frac{V_i^-}{V_j^+} \right|_{V_k^+ = 0 \text{ for } k \neq j}$$

$$|\Gamma_L| = \frac{VSWR - 1}{VSWR + 1}$$

$$\Phi_L = \pi(4\ell_{min} - 1)$$

$$Z_L = \frac{1 + \Gamma_L}{1 - \Gamma_L}$$



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical and Electronics Engineering
**BSc Hons (Eng) Automotive/ Electronic and Telecommunication/
Mechanical/ Mechatronics Engineering**
Semester 06 Re-Sit Examination 2024

Module Code	:	EE3324
Module Title	:	Control Systems
Date	:	4 th May 2024
Examiners	:	Mr. Randeera Liyanage
Time Allowed	:	1.00PM – 04.00PM; 03hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 4 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 10 pages.

MATERIALS REQUIRED

- CINEC answering Booklet; Extra answering paper, Log-linear sheet (Annex. I).
- You may use a scientific calculator. This must not be programmable. This may be examined during the examination.

Question 01

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 " $y(t)$ ".

Parameters - $k = 1 \text{ Nm}^{-1}$, $b = 60 \text{ Nsm}^{-1}$ and $m = 10 \text{ kg}$.

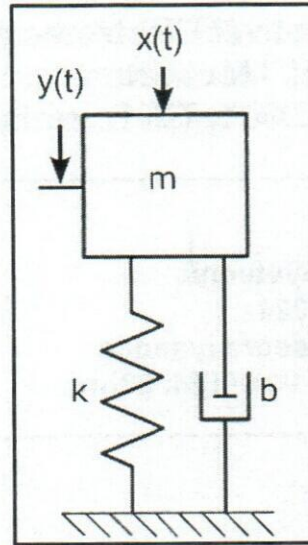


Figure 1 (a)

- a) **Derive** the transfer function via mathematical modelling. (*Parameter values must be substituted & simplified in the final answer*) (06 Marks)
- b) **Calculate** the following system characteristics,
 - i. Natural frequency (ω_n).
 - ii. Damping ratio (ζ).
 - iii. Steady state gain (K_{ss}).
 - iv. Settling time (T_s).
 (08 Marks)
- c) Using the transfer function derived in *Part a*, **draw** the pole-zero diagram and **comment** on the stability of the system with reference to pole locations. Hence **describe** the nature of oscillations of the system. (06 Marks)
- d) Using the system characteristics such as the damping ratio, **sketch** the time response of the system for a unit step input. (*System characteristic values obtained in (b) should be specified in the sketch*) (05 Marks)

[Question 01 Total – 25%]

Question 02

- 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.

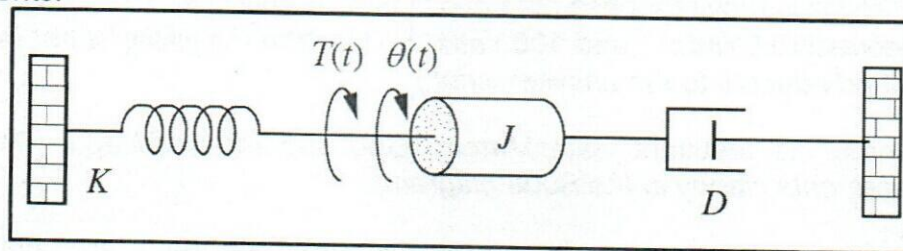


Figure 2 (a)

- i. **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)
- ii. Using the transfer function obtained in (i), **draw** the pole zero diagram and comment on the stability of the system. (04 Marks)
- iii. **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)
- iv. **Calculate** the steady state error using the open loop transfer function of the system for a unit step input. (04 Marks)
- v. 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)

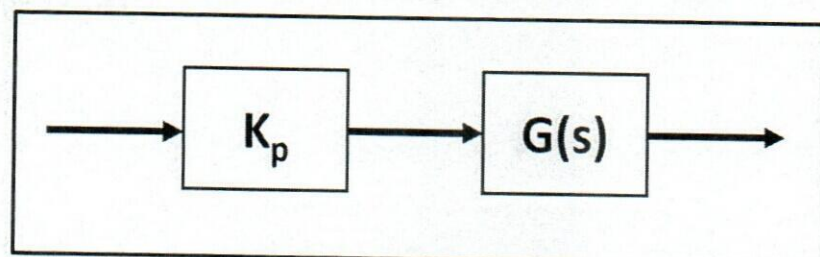


Figure 2 (b)

[Question 02 Total – 25%]

Question 03

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

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

- Using the open loop transfer function above, **derive** expressions for the frequency response (magnitude and phase). (04 Marks)
- Using the frequency response obtained in part "a", **plot** the bode diagram for the range of ω between 0.1 rads^{-1} and 100 rads^{-1} . (Use the log-linear sheet in **Annex. I** page 09/ 10 and attach it to the answer script.) (11 Marks)
- Determine** the resultant Gain Margin (GM) and Phase Margin (PM). (Show your measurements clearly in the Bode diagram). (02 Marks)
- 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).

Determine the value of gain "K" required to provide a Phase Margin, $PM = 70^\circ$

(06 Marks)

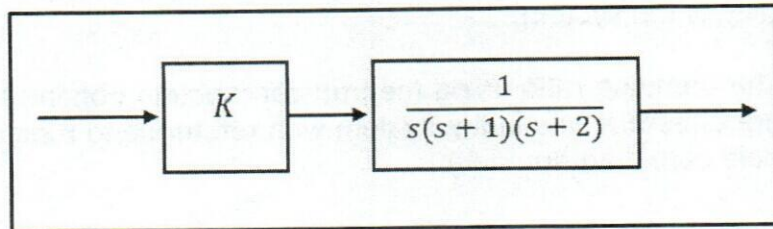


Figure 3 (a)

- Derive** an expression for the resulting open loop transfer function after cascaded gain compensator introduction. (02 Marks)

[Question 03 Total – 25%]

Question 04

- a) **Describe** three advantages of digital control compared to its analogue counterpart. (*Use 3 sentences for the explanation.*) (03 Marks)
- b) **Describe** one technique used to convert a digital control signal to an analogue actuator signal. Include a suitable diagram in your answer. (*Use 2 sentences for the description.*) (03 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 $0s \leq t \leq 3s$. (07 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 $0s \leq t \leq 3s$. (07 Marks)
- iv. **Describe** the compatibility with the digital controller's response. (*Use 2 sentences for the description.*) (02 Marks)

[Question 04 Total – 25%]

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

$$\begin{aligned} \text{Spring; } F &= kx(t) ; & \text{Damper; } F &= b\dot{x}(t) \\ \text{Capacitor Current; } I &= C \frac{dV_c}{dt} ; & \text{Inductor Voltage; } V &= L \frac{dI_L}{dt} \end{aligned}$$

Steady State Error

$$E(s) = R(s) - X(s) ; \quad E(s) = \frac{R(s)}{1 + G(s)}$$

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

$$E_{ss} = \lim_{s \rightarrow 0} s \cdot E(s)$$

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	$\frac{z}{z-\alpha}$
$\frac{1}{\tau} e^{-t/\tau}$	$\frac{1}{1+\tau s}$	$\frac{1}{\tau} e^{-kT/\tau}$	$\frac{1}{\tau} \frac{z}{z-e^{-T/\tau}}$
$1 - e^{-t/\tau}$	$\frac{1}{s(1+\tau s)}$	$1 - e^{-kT/\tau}$	$\frac{(1 - e^{-T/\tau})z}{(z-1)(z-e^{-T/\tau})}$
$1 - e^{-at}$	$\frac{a}{s(s+a)}$	$1 - e^{-akT}$	$\frac{(1 - e^{-aT})z}{(z-1)(z-e^{-aT})}$
-	-	$1 - \alpha^k$	$\frac{z(1-\alpha)}{(z-1)(z-\alpha)}$
$\sin(\omega t)$	$\frac{\omega}{s^2 + \omega^2}$		$\frac{z \sin \omega T}{z^2 - 2z \cos \omega T + 1}$
$\cos(\omega t)$	$\frac{s}{s^2 + \omega^2}$		$\frac{z(z - \cos \omega T)}{z^2 - 2z \cos \omega T + 1}$
$e^{-at} \sin \omega t$	$\frac{\omega}{(s+a)^2 + \omega^2}$		$\frac{z e^{-aT} \sin \omega T}{z^2 - 2z e^{-aT} \cos \omega T + e^{-aT}}$
$e^{-at} \cos \omega t$	$\frac{(s+a)}{(s+a)^2 + \omega^2}$		$\frac{z^2 - z e^{-aT} \cos \omega T}{z^2 - 2z e^{-aT} \cos \omega T + e^{-aT}}$

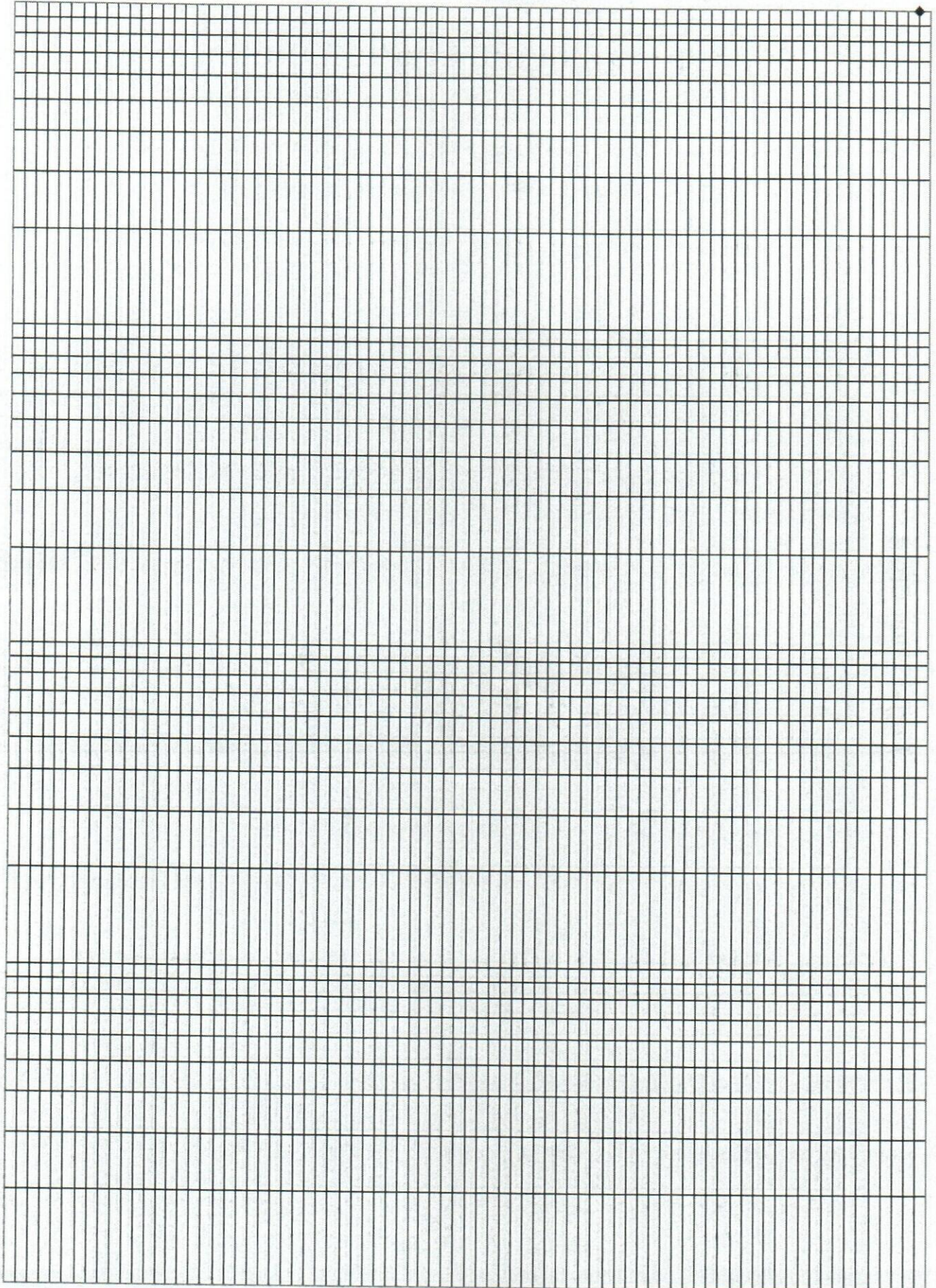
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Annex. I – LOG LINEAR SHEET

Student Id -

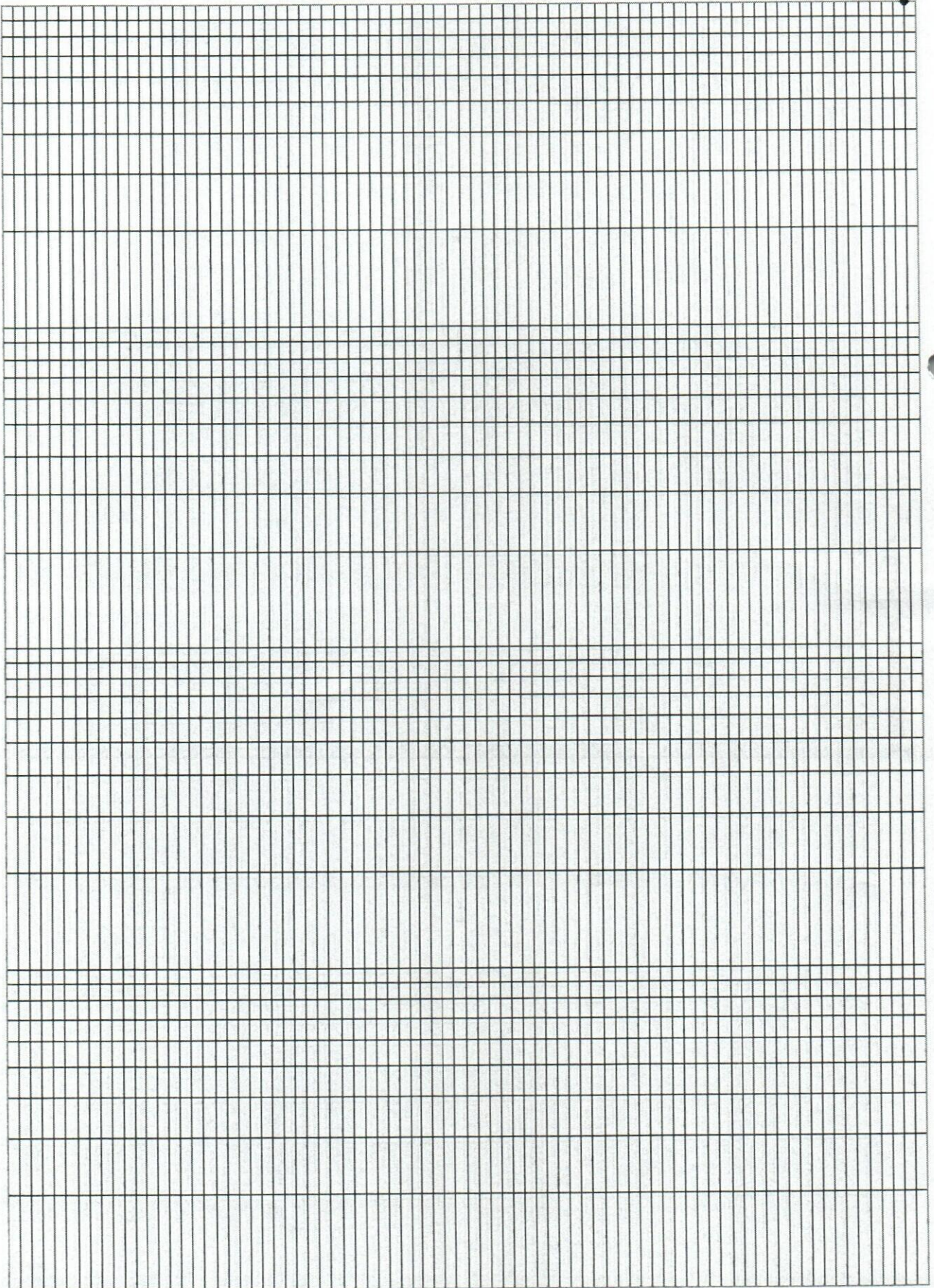
Log - Linear Chart



Annex. I – LOG LINEAR SHEET

Student Id -

Log - Linear Chart





CINEC Campus
Faculty of Engineering & Technology
Department of Electronics & Electrical Engineering
BSc Hons (Eng)
Semester 07 / Resit / Written Exam / 2024

Module Code	:	FE4311
Module Title	:	Ethics in Engineering
Date	:	05 th Apr 2024
Examiners	:	Eng. Wipula Wimalshanthi
Time Allowed	:	03 hrs.

INSTRUCTIONS TO CANDIDATES

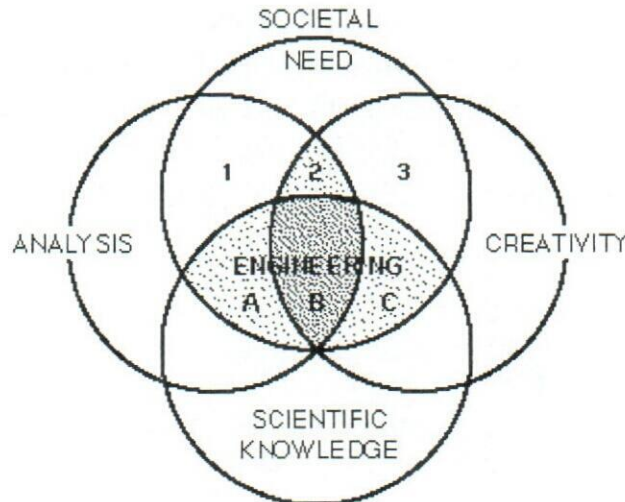
- This is a **closed book** examination.
- This paper consists of two (02) questions. You Should Answer all questions.
- Write clearly legibly with a blue or black pen.
- Use only the **CINEC Answering Booklet**. Additional sheets may be requested from the invigilators.
- This paper contains four (04) pages.

MATERIALS REQUIRED

- CINEC answering Booklet; Extra answering paper
- You may use copies of By-Laws of the Institution of Engineers, Sri Lanka (IESL), Code of Ethics and Rules provided during the examination

Question 1

- i) Refer the diagram illustrating the essential aspects of engineering profession and the effect on engineering domain by blending these aspects in the indicated proportions.



Briefly describe the resultant characteristics of engineering profession pertaining to Sectors A, B and C, giving relevant examples.

Also, comment on the areas of activities represented by Sectors 1, 2 and 3, giving relevant examples.

[06 Marks]

- ii) Identify six (06) characteristics of a successful engineer paraphrasing each quality as per your understanding.

[06 Marks]

- iii) Take an example of one of the Nationally important projects in Sri Lanka, which has not delivered its expected benefits to the country. Explain the reasons for failure to deliver the expected benefits to the country highlighting any poor Engineering decisions and any economic considerations, risk and public safety issues that may have been overlooked.

[06 Marks]

- iv) Write short answers for the following questions with appropriate references to 'Code of Ethics' of IESL.

- What is the primary duty of engineers according to the IESL Code of Ethics?
- IESL 'Guidelines for Professional Conduct' include a Clause to ensure that Engineers do not engage in practices that are likely to discredit the profession. Identify this Clause and state the related sub-clauses. This requirement is also covered under the 'Code of Ethics' of IESL. Identify the relevant Clause and Rules specified under Code of Ethics as well.

[06 Marks]

- v) Professional values are deemed to impact customer relations in a significant manner.

Name at least 04 positive impacts on customer relations with brief descriptions.

[06 Marks]

Question 2

Read the Case given below carefully and answer the questions given at the end.

Kudochem is a multinational chemical company producing chemicals for the agricultural industry. Responsibility for engineering issues at the 11 Kudochem chemical plants in Europe, primarily in the UK, Germany and the Czech Republic lies with Kudochem's European Regional Engineering Director, Sally Proctor.

In the early hours of one morning, Sally receives a telephone call informing her that there has been a serious explosion at one of the plants. There have been some injuries, and damage has been done to property several hundred metres from the plant, but there have been no fatalities. The scale of the damage is huge, and the main site of the chemical plant is almost completely destroyed.

In accordance with company policy, an inquiry team is set up, involving company employees as well as independent consultants. After several weeks, the team discovers two possible causes, both relating to a new ammonia production technique for fertiliser, which has recently been introduced in all of Kudochem's plants. They are unable to determine which of these two possible causes are responsible. Given the presence of the flawed procedure in all of Kudochem's plants, it is imperative that the ultimate cause of the explosion is identified, so that urgent steps can be taken to safeguard against similar accidents at other sites.

The inquiry team is very concerned at their inability to determine the cause of the accident. Without this knowledge, it will be impossible to satisfactorily modify the plants in order to prevent future explosions of this kind. They make a radical recommendation: to call a meeting with several competitor companies who are also using the new procedure in their fertilizer plants, in order to share experiences and research findings.

This would be a significant departure from standard practice, and some senior colleagues with commercial responsibilities have reservations. To call the meeting would entail releasing information about the safety lapse, as well as discussing sensitive commercial information with business rivals. However, it may be the case that other engineers in other companies have encountered problems with the new method for producing ammonia, and could offer help in isolating the problem. Whilst such a course of action may be unusual in this case there are industries where safety critical information is routinely shared amongst competitors.

Assuming that you are the European Regional Engineering Director for this multinational chemical company, after an explosion at a chemical plant, you have responsibility for preventing similar accidents at 10 other sites. The inquiry team has been unable to identify the cause with complete accuracy, and they have recommended that you initiate discussions with competitor companies to pool knowledge. This would be unconventional, and would entail significant commercial risk.

- (i) Given the recommendations of inquiry team, what action would you take to prevent such a disaster happening again?
- (ii) Will you consider alternate courses of action, and if so what are they?
- (iii) Assuming that Code of ethics of IESL is applicable in this instant, analyze this scenario and identify any violations of engineering code of ethics.

[40 Marks]

Disclaimer: The case given above is totally fictitious and has no relation to any organizations or living / deceased persons.

- d) Find the value of R_L in Figure 1.3 necessary to obtain maximum power in R_L . Also, find the maximum power in R_L .

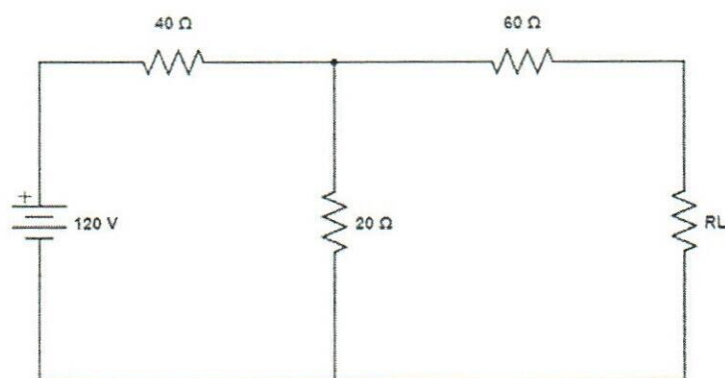


Figure 1.3

(5 Marks)

2)

- a) In the circuit shown in Figure 2.1, the capacitor is initially uncharged, and $V=10V$. At time $t=0$, switch S is closed. If τ denotes the time constant, what is the approximate current through the 3Ω resistor, when $t = \tau/10$?

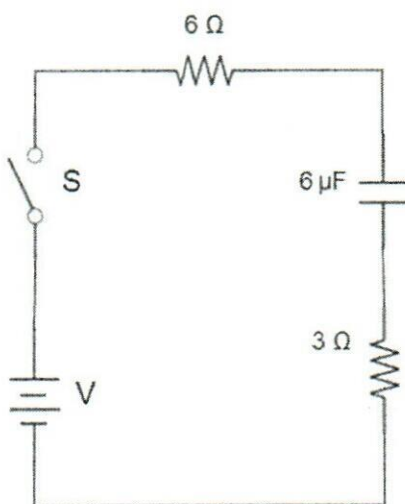


Figure 2.1

(5 Marks)

- b) Suppose we have an RC circuit with the following parameters:

Resistance (R) : $1\text{k}\Omega$

Capacitance (C): $1\mu\text{F}$

Input Voltage (V_{in}) : 10V

Calculate the voltage across the capacitor ($V_c(t)$) at $t = 2\tau$ where τ is the time constant of the circuit.

(5 Marks)

- c) Determine the governing differential equation for the following circuit in Figure 2.2. Express the answer in standard form and determine the capacitor value when the circuit has a critical damping response.

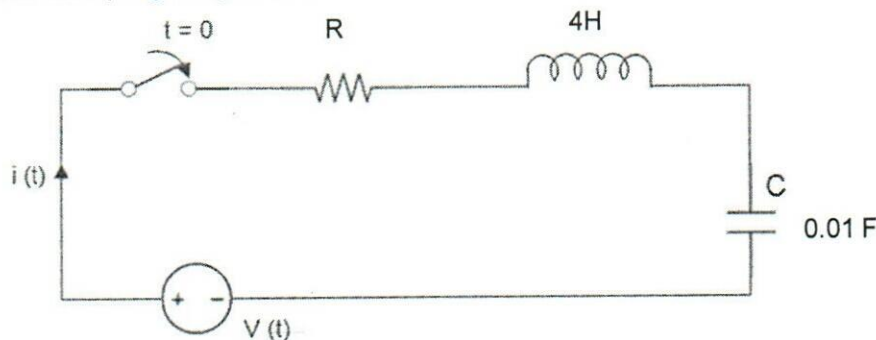


Figure 2.2

(10 Marks)

- 3) A parallel circuit consists of a coil with a resistance of 22Ω and an inductance of 3.3mH . This parallel combination is connected in series with a circuit that includes a 15Ω resistor in series with a $0.1\mu\text{F}$ capacitor. Furthermore, this entire circuit is connected in series with a $1\text{k}\Omega$ resistor. The entire arrangement is connected to a voltage source represented by $v(t) = 34 \sin(1000t)$.

Calculate,

- a) Total impedance.

(5 Marks)

- b) Total current.

(5 Marks)

- c) Current through all elements of the circuit.

(7 Marks)

- d) Active power, reactive power, apparent power, and power factor.

(4 Marks)

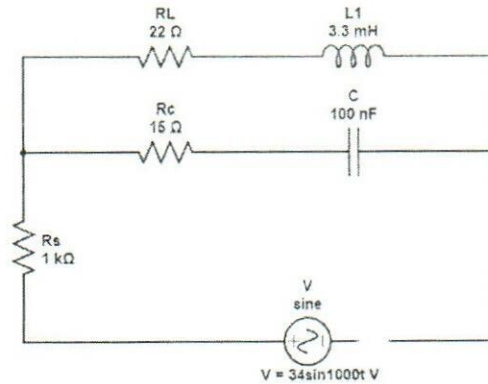


Figure 3.1

- d) For the circuit in Figure 3.1, Calculate the resonance frequency. (8 Marks)
- e) In an RLC series circuit, the resistance R is 10 ohms, the inductance L is 20 mH, and the resonant frequency (f_{res}) is 100 Hz. Calculate the capacitance (C) needed for the circuit to be at resonance. (5 Marks)
- f) Explain the significance of power factor in an RLC circuit. (1 Marks)
- g) A coil of resistance 15Ω and inductance 0.5H is connected to a 250V , 50Hz supply. Calculate the capacitance of the capacitor to be connected in parallel with the coil as shown in Figure 3.2 so that the overall power factor is unity. Also, find the supply current also. (The capacitor value and supply current **must** be calculated using a phasor diagram.)

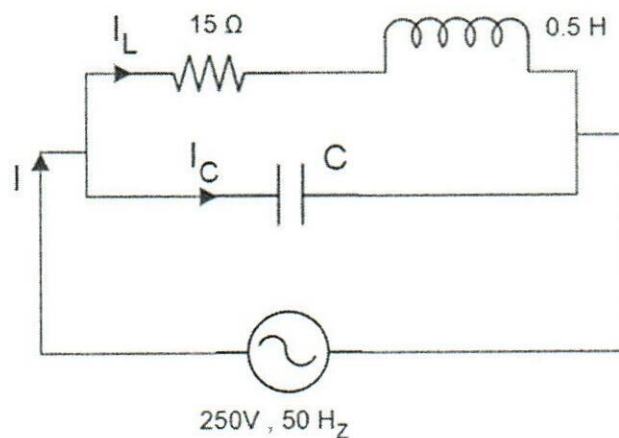


Figure 3.2

(5 Marks)

4)

- a) Draw the circuit diagram for a full wave bridge rectifier by using four diodes and transformer and resistor.

(1 Mark)

- b) From the above circuit, sketch the input and output waveforms.

(1 Mark)

- c) In your own words, comment the new out waveform if a capacitor is connected in parallel to the above full-wave rectifier circuit.

(1 Mark)

- d) Voltmeter with an internal resistance of $1k\Omega$ require $10mA$ to produce full scale deflection. Calculate the value of the series resistance needed to measure $50V$ of full scale.

(2 Marks)

- e) A $1mA$ meter movement with an internal resistance of 100Ω is to be converted into a $1-100mA$. Calculate the value of shunt resistance required.

(2 Marks)

- f) Calculate the force on a unit positive charge at P on X-axis whose co-ordinates are $(x=2m, y=0)$ due to the following two charges:

i) A positive charge of $10^{-9}C$ situated in air at the origin $(x=0, y=0)$

ii) A negative charge of $-2 \times 10^{-9}C$ situated on X-axis $(x=1m, y=0)$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$$

(2 Marks)

- g) A coil of 100 turns is linked by a magnetic flux of $20mWb$. If this magnetic flux is reversed in a time of $2ms$. Calculate the average e.m.f induced in the coil.

(2 Marks)

- h) Explain Biot-Savart law.

(2 Marks)

- j) With its help derive an expression for the magnetic field at the centre of a current carrying circular loop.

(2 Marks)

Data Sheet

$$V_c(t) = \frac{1}{C} \int I_c(t) dt$$

$$I_c(t) = C \cdot \frac{dV_c}{dt}$$

$$V_L(t) = L \cdot \frac{dI_L}{dt}$$

$$I_L(t) = \frac{1}{L} \int V_L(t) dt$$

$$\tau = L/R$$

$$\tau = RC$$

$$V = I(R_n + R_m)$$

$$I_m = \left(\frac{R_n}{R_n + R_m} \right) I_{fs}$$



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Civil/Mechanical/Automotive/Mechatronics/Electronic &
Telecommunication Engineering
Semester 1 First Sit Final Examination 2024

Module Code	:	EE1315
Module Title	:	Electricity
Date/Time	:	11 th February 2024
Examiners	:	A.A.Hashini Athauda
Time Allowed	:	3 hours; 1330-1630h

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 04 questions. You should answer **ALL** questions.
- Write clearly legibly with a blue or black pen.
- Show all stages of your work.
- Use only the CINEC Answering Booklet. Additional sheets may be requested from the invigilators.
- This paper contains 7 pages.

MATERIALS REQUIRED

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

1. a) Apply Norton's theorem to the circuit in Figure 1.1 and find the equivalent circuit at terminal a-b

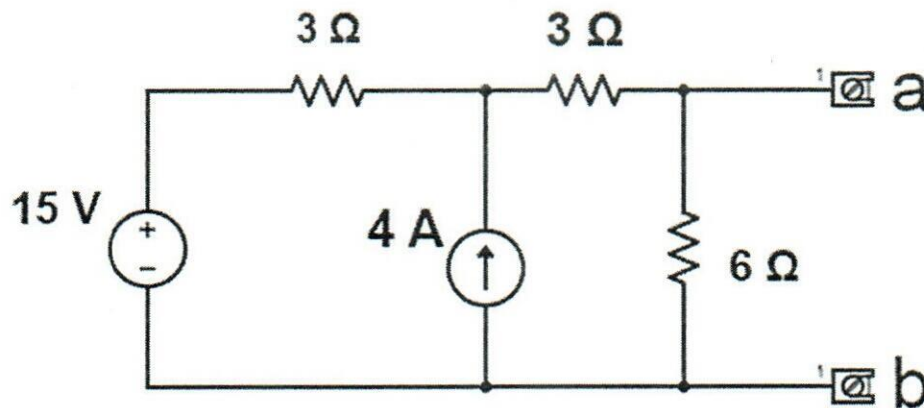


Figure 1.1

- b) Connect the load resistor R_L ($R_L=8\Omega$) across terminal a-b and find the current through the 8Ω resistor

(10 Marks)

- c) Using Millman's theorem, find the current flowing through the load resistance R_L in the circuit of Figure 1.2

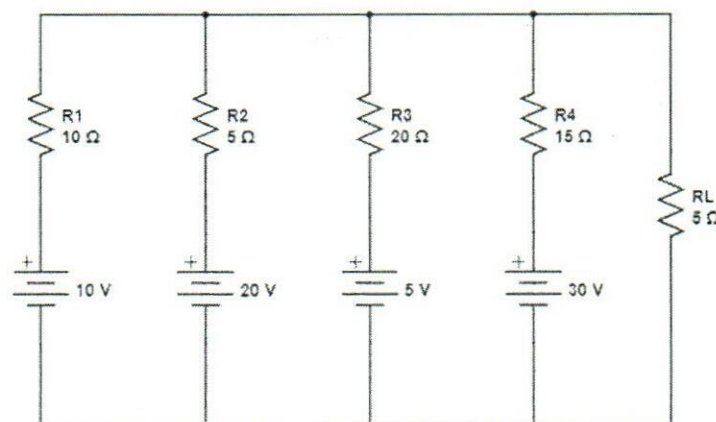


Figure 1.2

(10 Marks)

- d) Find the value of R_L in Figure 1.3 necessary to obtain maximum power in R_L . Also, find the maximum power in R_L .

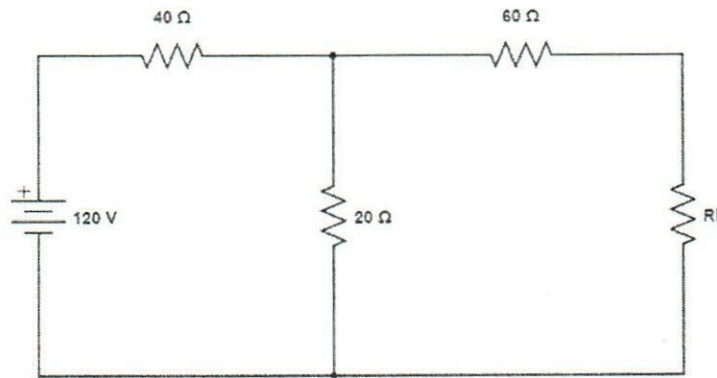


Figure 1.3

(5 Marks)

2)

- a) In the circuit shown in Figure 2.1, the capacitor is initially uncharged, and $V=10V$. At time $t=0$, switch S is closed. If τ denotes the time constant, what is the approximate current through the 3Ω resistor, when $t = \tau/10$?

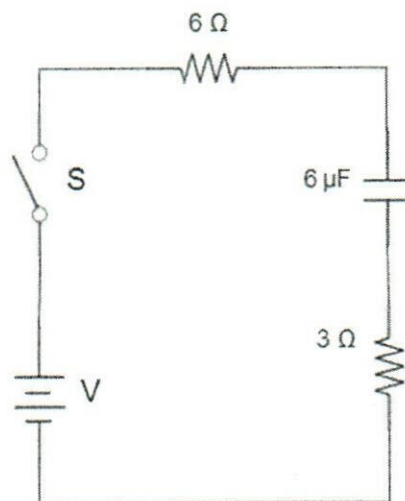


Figure 2.1

(5 Marks)

- b) Suppose we have an RC circuit with the following parameters:

Resistance (R) : $1\text{k}\Omega$

Capacitance (C): $1\mu\text{F}$

Input Voltage (V_{in}) : 10V

Calculate the voltage across the capacitor ($V_c(t)$) at $t = 2\tau$ where τ is the time constant of the circuit.

(5 Marks)

- c) Determine the governing differential equation for the following circuit in Figure 2.2. Express the answer in standard form and determine the capacitor value when the circuit has a critical damping response.

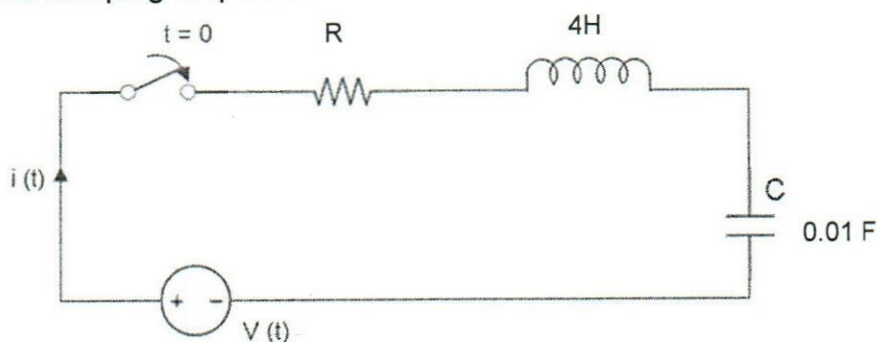


Figure 2.2

(10 Marks)

- 3) A parallel circuit consists of a coil with a resistance of 22Ω and an inductance of 3.3mH . This parallel combination is connected in series with a circuit that includes a 15Ω resistor in series with a $0.1\mu\text{F}$ capacitor. Furthermore, this entire circuit is connected in series with a $1\text{k}\Omega$ resistor. The entire arrangement is connected to a voltage source represented by $v(t) = 34 \sin(1000t)$.

Calculate,

- a) Total impedance.

(5 Marks)

- b) Total current.

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- c) Current through all elements of the circuit.

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- d) Active power, reactive power, apparent power, and power factor.

(4 Marks)

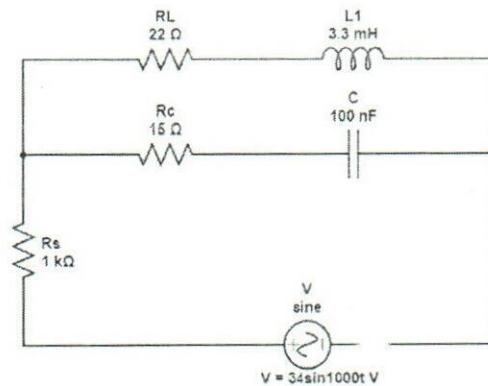


Figure 3.1

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- g) A coil of resistance 15Ω and inductance 0.5H is connected to a 250V , 50Hz supply. Calculate the capacitance of the capacitor to be connected in parallel with the coil as shown in Figure 3.2 so that the overall power factor is unity. Also, find the supply current also. (The capacitor value and supply current **must** be calculated using a phasor diagram.)

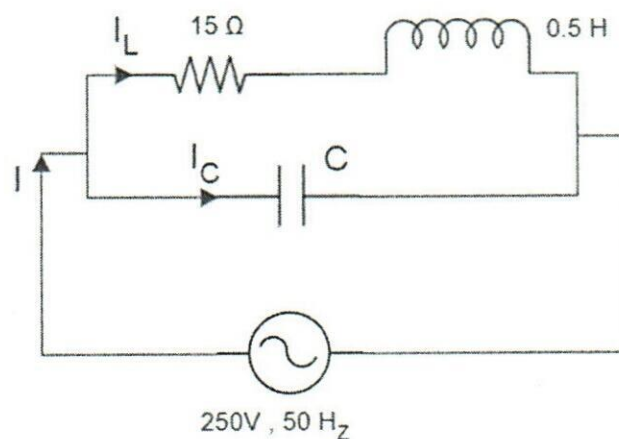


Figure 3.2

(5 Marks)

4)

- a) Draw the circuit diagram for a full wave bridge rectifier by using four diodes and transformer and resistor.

(1 Mark)

- b) From the above circuit, sketch the input and output waveforms.

(1 Mark)

- c) In your own words, comment the new out waveform if a capacitor is connected in parallel to the above full-wave rectifier circuit.

(1 Mark)

- d) Voltmeter with an internal resistance of $1\text{k}\Omega$ require 10mA to produce full scale deflection. Calculate the value of the series resistance needed to measure 50V of full scale.

(2 Marks)

- e) A 1mA meter movement with an internal resistance of $100\ \Omega$ is to be converted into a $1\text{-}100\text{mA}$. Calculate the value of shunt resistance required.

(2 Marks)

- f) Calculate the force on a unit positive charge at P on X-axis whose co-ordinates are $(x=2\text{m}, y=0)$ due to the following two charges:

i) A positive charge of 10^{-9}C situated in air at the origin $(x=0, y=0)$

ii) A negative charge of $-2 \times 10^{-9}\text{C}$ situated on X-axis $(x=1\text{m}, y=0)$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$$

(2 Marks)

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(2 Marks)

- h) Explain Biot-Savart law.

(2 Marks)

- j) With its help derive an expression for the magnetic field at the centre of a current carrying circular loop.

(2 Marks)

Data Sheet

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$$V_L(t) = L \cdot \frac{dI_L}{dt}$$

$$I_L(t) = \frac{1}{L} \int V_L(t) dt$$

$$\tau = L/R$$

$$\tau = RC$$

$$V = I(R_n + R_m)$$

$$I_m = \left(\frac{R_n}{R_n + R_m} \right) I_{fs}$$



CINEC Campus
Faculty of Engineering & Technology
Department of Electronics Engineering
BSc Hons (Eng) Automotive, Mechanical, Civil, Mechatronics, Electronic & Telecommunication Engineering
Semester 3 / First Sit / Written Exam / 2024

Module Code	:	FE2313
Module Title	:	Engineering Profession
Date	:	10 th Feb 2024
Examiner	:	Eng. Wipula Wimalshanthi
Time Allowed	:	03 hrs.

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 02 Sections. **Section A** consists of **20 multiple choice questions** and **Section B** consists of **04 descriptive type questions**. You should Answer **ALL** questions.
- Write clearly legibly with a blue or black pen.
- Use only the **CINEC Answering Booklet**. Answers to multiple choice questions shall be marked on the given **Answer Sheet**. Additional sheets may be requested from the invigilators.
- This paper contains **06** pages.

Section A**[Total of 30 Marks]**

- 1) What is the phase of Engineering history that has matured after the World war II?
 - a) Second Industrial revolution.
 - b) Industrial revolution.
 - c) Pre-historic revolution.
 - d) Information revolution
- 2) Which one of the following combination is not considered as essential aspects of engineering?
 - a) Creativity + Scientific knowledge
 - b) Analytical skills + Scientific knowledge
 - c) Societal needs + Creativity
 - d) Scientific knowledge + Societal needs+ Analytical skills
- 3) Which one of the following group of attributes are identified as most essential for engineering professionals?
 - a) Customer focus, integrity, presentability
 - b) Communication, Teamwork, engineering knowledge
 - c) Innovation, courage, empathy
 - d) Safety awareness, general knowledge, initiative
- 4) Some of the remarkable engineering achievements were found to have been made during 3000 – 600 B.C. Basic arithmetic and algebra, computing areas and volumes were few of them. Who were responsible for such feats?
 - a) Egyptian engineers
 - b) Greek engineers
 - c) Babylonian engineers
 - d) Roman engineers
- 5) Which one of the following sentences correctly identifies the inventions made during 17th & 18th centuries, which is also called the period of revival of science?
 - a) Pieter van Musschenbroek developed a device to hold static electrical charge (Leyden Jar)
 - b) Method of refining Iron, developed by Henry Cort
 - c) Michael Faraday developed means to generate electricity by moving a conductor through magnetic field
 - d) Jagadis Chandra Bose demonstrates transmission of electric signals through space
- 6) During the 20th century, John Bardeen, Walter Brattain and William Shockley (Bell Labs) discovered current changes in one part of a Diode cause current changes in another part of a Diode.
This device is now called as;
 - a) The Schottky diode
 - b) The Transistor
 - c) The Klystron
 - d) The Tunnel diode

- 7) Which one of the following would be the primary reason for developing soft skills in engineers?
- For continuing professional development
 - For interacting effectively with others in communicating, collaborating and solving problems
 - For communicating effectively with customers and ensuring customer satisfaction
 - To become an effective leader
- 8) The ability to perceive and relate to thoughts, emotions or experiences of others is identified as;
- Empathy
 - Kindness
 - Cognitive adaptability
 - Emotional adaptability
- 9) Some of the specific soft skills that are identified as organization soft skills are;
- Innovativeness, punctuality, Teamwork
 - Self-control, patience, adaptability
 - Customer service, public speaking, Integrity
 - Time management, Goal setting, planning, prioritisation
- 10) What is the false statement regarding 'Creativity' and 'Innovation'?
- Creativity is related to imagination and innovation is related to implementation
 - Creativity is a personal quality and Innovation is an organizational process
 - Creativity can be measured and innovation cannot be measured
 - Creativity has no direct risk factors and innovation has a risk of failure
- 11) In almost every field of engineering best practices, technologies and the requirements of customers change fast. Therefore, if engineers are to be successful they shall be adaptable and not merely enough to be open for change. If you want to be a successful engineer, how would you develop this characteristic?
- Being more efficient and effective
 - Continuously seeking to explore and improve
 - By developing problem solving skills
 - By being a good team player
- 12) The amount of risk an organization is willing to accept in pursuit of value is identified as;
- Risk Thermostat
 - Residual risk
 - Risk appetite
 - Net risk assessment
- 13) The process of understanding and managing the risks that the organization is inevitably subjected to in attempting to achieve its corporate objectives is identified as;
- Risk management
 - Risk evaluation
 - Risk analysis
 - Risk reporting

- 14) Once the risks are identified, described, estimated and mapped, it is required to record the risks in a Risk Register. A subset of data to be recorded would be;
- a) Date of identification of risk, likelihood of occurring, Strategic objectives of the organization
 - b) Impact, resources utilized, likelihood of occurring
 - c) Impact, Date risk identified, likelihood of occurring
 - d) Financial impact, resources utilized, Risk number
- 15) One of the foremost tasks of planning for a meeting would be;
- a) Compilation of an action plan
 - b) Identification of the purpose of the meeting
 - c) Setting a venue and time
 - d) Identification of participants
- 16) Which one of the following Project Management methodologies uses the Gantt chart most effectively?
- a) Scrum
 - b) Kanban
 - c) Extreme Project Management
 - d) Critical Path
- 17) One of the process-based project management methodologies would be;
- a) Lean six-sigma
 - b) Extreme Project Management (XPM)
 - c) Critical Chain Project Management (CCPM)
 - d) Waterfall
- 18) Characteristic of a 'Holistic Team' would be;
- a) Sharing equal amount of work among its members
 - b) Highly disciplined
 - c) Total output is greater than the sum of individual member's output
 - d) Experts in all the subject areas are involved in the expected outcome
- 19) According to Belbin's Team Theory, a team member who specifies advancing new ideas and strategies with special attention to major issues; looking for possible breaks in approach to the problem with which the group is confronted, is identified as;
- a) Monitor – Evaluator (ME)
 - b) Team Worker (TW)
 - c) Complete Finisher (CF)
 - d) Plant (PL)
- 20) One of the Belbin's eight team roles requires the ability to specify turning concepts, plan into practical working procedures and carrying out agreed plans systematically and efficiently. This team role is identified as;
- a) Resource Investigator (RI)
 - b) Company Worker (CW)
 - c) Shaper (SH)
 - d) Team Worker (TW)

Section B

[Total of 70 Marks]

Question 1

[10 Marks]

- 1.1) Define in your own words, who is a Professional. And then define who is a Professional Engineer.

[04 Marks]

- 1.2) Broadly, the following categories of personnel could be identified as included in "The Technology Team" responsible for development and application of technology, fulfilling the needs of society.

- i. Scientist
- ii. Engineer
- iii. Technician

Briefly describe the functions carried out by each category, in doing so.

[06 Marks]

Question 2

[14 Marks]

- 2.1) Problem solving is known as one of the soft skills essential for engineers. State the six (06) techniques (steps) involved in solving an engineering problem in a systematic manner.

[04 Marks]

- 2.2) Name at least three (03) soft skills that are closely related to problem-solving skills.

[04 Marks]

- 2.3) Name four (04) soft communication skills that are essential for Engineers in pursuing a successful career. For each soft skill identified, briefly discuss the advantages of possessing such soft skills including recommended means of developing them.

[06 Marks]

Question 3

[25 Marks]

- 3.1) What is the typical definition of a Risk?

[02 Marks]

- 3.2) What are the four (04) widely known types of Risks? Give real life examples for each type of risk.

[06 Marks]

- 3.3) Most common way of assessing risk is risk mapping through an impact / likelihood matrix. Draw a 3 x 3 Risk Map indicating 'Possible', 'Probable' and 'Remote' Likelihood levels and 'Low', 'Medium' and 'High' Impact levels and identify the risk area where immediate mitigation action is required and the risk area where no mitigatory action is needed.

[04 Marks]

- 3.4) What is the standard definition for "Project"? Discuss the meaning of key words used.
[06 Marks]
- 3.5) What is meant by Project Management? Identify the four (04) stages of Project Management and briefly explain the functions of each stage.
[07 Marks]

Question 4

[21 Marks]

Case study:

You have been assigned the position of Environmental Engineer for one of several local plants of Company ABC, whose water discharges flow into a lake in a flourishing tourist area.

Although all the plants of Company ABC are marginally profitable, they compete for the same customers.

Included in your responsibilities is the monitoring of water and air discharges at your plant, the periodic preparation of reports to be submitted to the Central Environmental Authority of Sri Lanka (CEASL) and assisting periodic environmental audits carried out by CEASL. You have just prepared a report that indicates that the level of pollution in the plant's water discharges slightly exceeds the legal limitations. Your supervisor, the Plant Manager, says you should regard the excess as a mere "technicality," and he asks you to "adjust" the data so that the plant appears to be in compliance. He says that the slight excess is not going to endanger human or fish life any more than if the plant were actually in compliance.

However, he says, solving the problem would require a very heavy investment in new equipment. He explains, "We can't afford new equipment. It might even cost a few jobs. It will set us behind our competitors. Besides the bad publicity we'd get, it might scare off some of the tourist industry, making it worse for everybody."

- i) Describe your basic responsibilities as an Environmental Engineer in this plant?
- ii) What would be your response to the Plant Manager's request as a professional engineer? Describe in detail the reasons for your decision considering Responsibilities, Accountabilities of Professional Engineers. (Assuming that you don't decide to leave the Company). What action will you propose based on your response.

[Combined descriptive answers shall be of 500 words minimum]

Disclaimer: The case given above is totally fictitious and has no relation to any organizations or living / deceased persons.



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical & Electronic Engineering
BSc Hons (Eng) Civil/Mechanical/Automotive/Mechatronics/Electronic &
Telecommunication Engineering
Semester 1 First Sit Final Examination 2024

Module Code	:	EE1315
Module Title	:	Electricity
Date/Time	:	11 th February 2024
Examiners	:	A.A.Hashini Athauda
Time Allowed	:	3 hours; 1330-1630h

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 04 questions. You should answer **ALL** questions.
- Write clearly legibly with a blue or black pen.
- Show all stages of your work.
- Use only the CINEC Answering Booklet. Additional sheets may be requested from the invigilators.
- This paper contains 7 pages.

MATERIALS REQUIRED

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

1. a) Apply Norton's theorem to the circuit in Figure 1.1 and find the equivalent circuit at terminal a-b

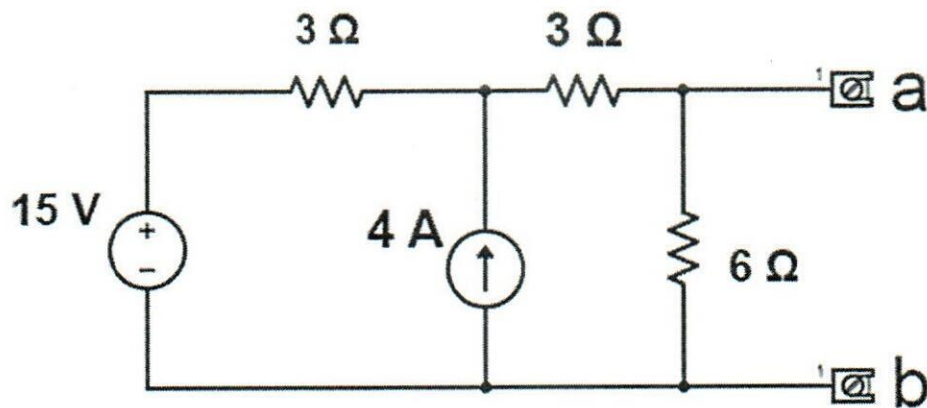


Figure 1.1

- b) Connect the load resistor R_L ($R_L=8\Omega$) across terminal a-b and find the current through the 8Ω resistor

(10 Marks)

- c) Using Millman's theorem, find the current flowing through the load resistance R_L in the circuit of Figure 1.2

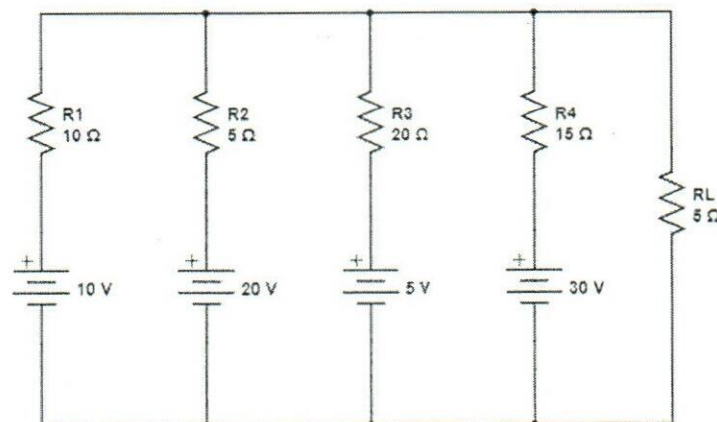


Figure 1.2

(10 Marks)



CINEC Campus
Faculty of Engineering & Technology
Department of Electrical & Electronics Engineering
BSc Hons (Eng) in Mechanical Engineering / Electronic and
Telecommunication Engineering
Semester 3 - End Semester Examination – First Sit
2024 February

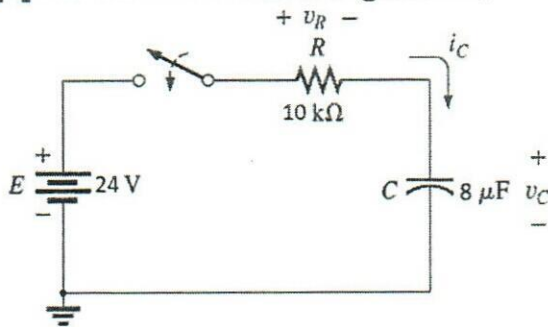
Module Code	:	EE2314
Module Title	:	Analogue Electronics
Date	:	2024-02-14
Examiners	:	MGJP Fernando
Time Allowed	:	3 Hrs

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination.
- This paper consists of 5 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 6 pages.
- Consider $V_{BE} = 0.7V$

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 [20 Marks]**[a]** For the RC circuit in **Figure 1.1**,**Figure 1.1**

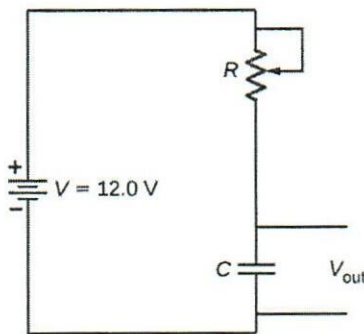
[i] Find the mathematical expression for the transient behaviour of v_C , i_C , and v_R if the switch is closed at $t = 0$.

[ii] Plot the waveform of v_C versus the time constant of the network.

[iii] Plot the waveform of i_C versus the time constant of the network.

[iv] Find the value of v_C when $t = 100\text{ms}$.

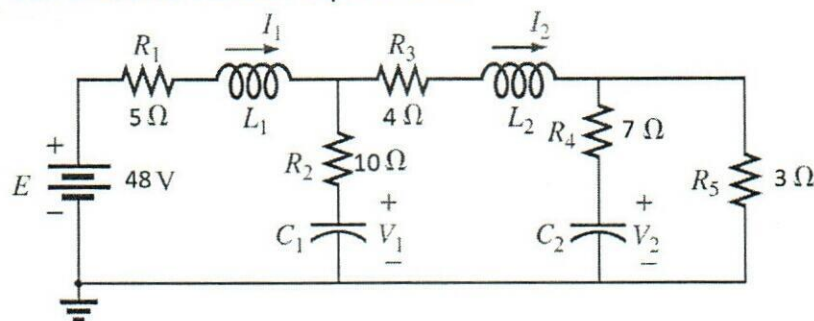
[v] What is the time taken for the capacitor to be fully charged?

[10]**[b]** **Figure 1.2** shows a relaxation oscillator is used to control a pair of windshield wipers.**Figure 1.2**

- The relaxation oscillator consists of a 20 mF capacitor and a 12 kΩ rheostat.
- A knob connected to the variable resistor allows the resistance to be adjusted from 0 Ω to 12 kΩ.
- The output of the capacitor is used to control a voltage-controlled switch which is normally open, but when the output voltage reaches 8 V, the switch closes, energizing an electric motor and discharging the capacitor.
- The motor causes the windshield wipers to sweep once across the windshield and the capacitor begins recharging.

[i] To what resistance should the rheostat be adjusted for the period of the wiper blades be 5 seconds?

[ii] What is the period of operation for the maximum resistance value?

[4]**[c]** For the network in **Figure 1.3**, find I_1 , I_2 and V_1 , V_2 when the network is in steady state by substituting open circuit and short circuit equivalents.**Figure 1.3****[3]****[d]** Discuss advantages and disadvantages of Analog electronic circuits.**[3]**

Question 02 [20 Marks]

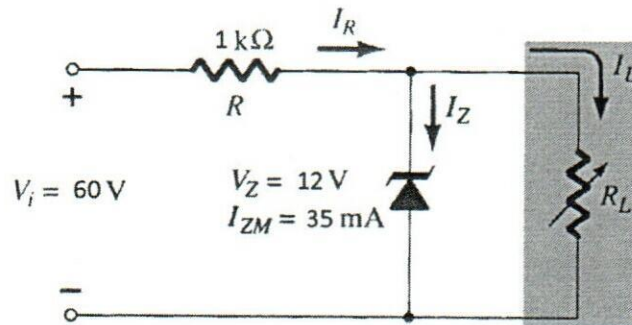
[a] Describe the Fermi Dirac Distribution Function.

[3]

[b] Explain how Avalanche breakdown and Zener breakdown occur in a PN diode

[3]

[c] For the Voltage Regulator shown in **Figure 2.1**, determine the range of I_L and R_L that will result in V_{RL} being maintained at 12 V.

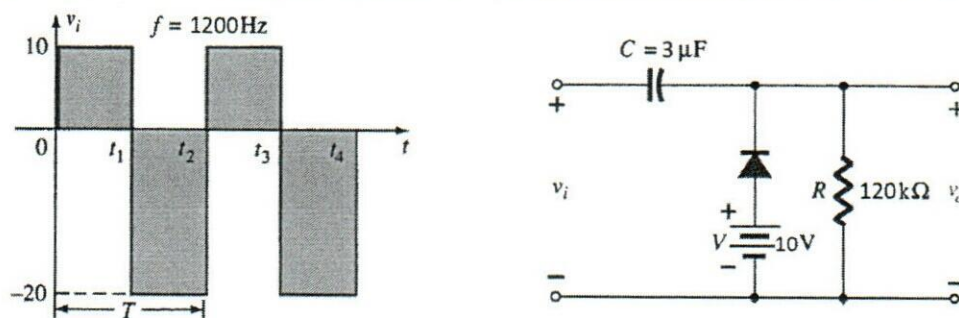
**Figure 2.1**

[5]

[d] Illustrate the Voltage Tripler and Quadrupler circuit.

[5]

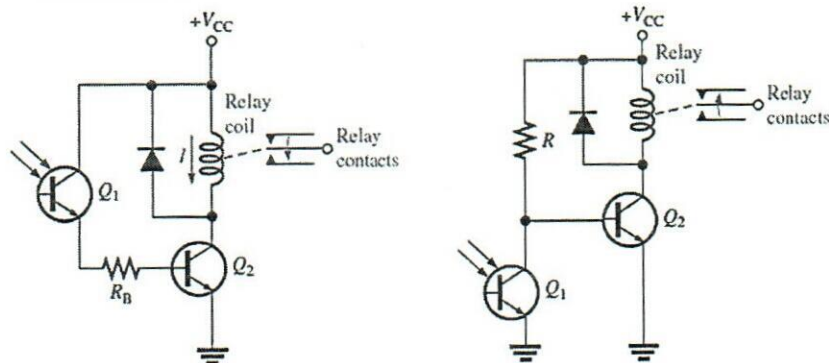
[e] **Figure 2.2** shows a Voltage clamper and the input signal given to the circuit. Find the output voltage and draw the output waveform. (Neglect the voltage drop across the diode)

**Figure 2.2**

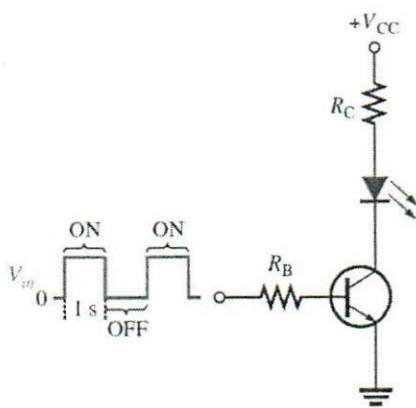
[4]

Question 03 [20 Marks]

[a] Figure 3.1 shows a phototransistor switch. Describe how a relay switching can be controlled by a phototransistor.

**Figure 3.1****[4]**

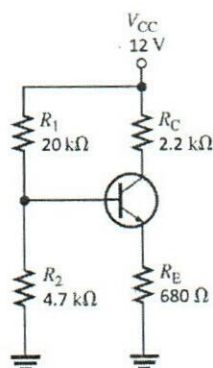
[b] Figure 3.2 shows a transistor used as a switch to turn an LED on and off using a pulse.

**Figure 3.2**

- A square wave input voltage with a period of 2 s is applied to the input.
- The LED require 1.2V to operate and 35mA current to emit the desired level of light.
- If $V_{CC} = 10V$, $V_{CE(Sat)} = 0.5V$, $V_{BE} = 0.7V$, $R_C = 270\Omega$, $R_B = 3.6k\Omega$, find the amplitude of the square wave input voltage necessary to saturate the transistor.
- Consider DC gain as 50.
- Use the base current as twice the minimum value of base current, as a safety margin to ensure saturation.

[4]

[c] Figure 3.3 shows a Voltage-divider biased transistor circuit. If the DC gain is 120, calculate V_{CE} and I_C .

**Figure 3.3****[4]**

[d] Illustrate the Base-biased, Emitter biased, Emitter-feedback biased and Collector-feedback biased BJT circuits.

[8]

Question 04 [20 Marks]

[a] What is the purpose of a cascaded multistage amplifier?

[2]

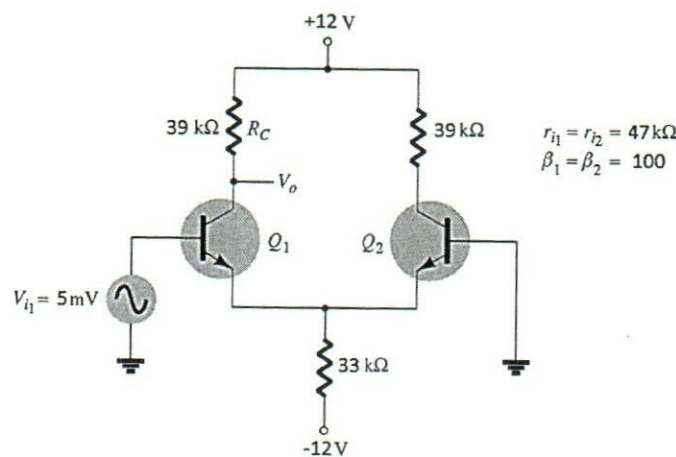
[b] A certain cascaded amplifier arrangement has voltage gains of $A_{v1} = 12$, $A_{v2} = 16$, $A_{v3} = 22$ and $A_{v4} = 28$.

[i] Find the overall voltage gain

[ii] Express each gain in decibels (dB) and determine the total voltage gain in dB

[4]

[c] The differential amplifier in **Figure 4.1** receives a single-ended input voltage. Calculate the output voltage V_o



$$I_E = \frac{V_{EE} - V_{BE}}{R_E}$$

$$I_C = \frac{I_E}{2}$$

$$v_C = v_{CC} - I_C R_C$$

$$A_v = \frac{R_C}{2r_e}$$

$$r_{i1} = r_{i2} = \beta r_e$$

$$V_o = A_v V_i$$

Figure 4.1

[5]

[d] Explain the 'Common Mode Rejection'.

[5]

[e] A differential amplifier has a differential voltage gain of 1000 and a common-mode gain of 0.4. Determine the CMRR and express it in decibels.

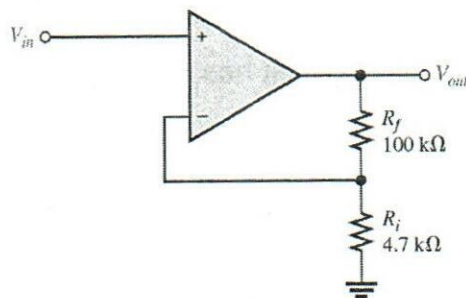
[4]

Question 05 [20 Marks]

[a] State the characteristics of an ideal op-amp.

[3]

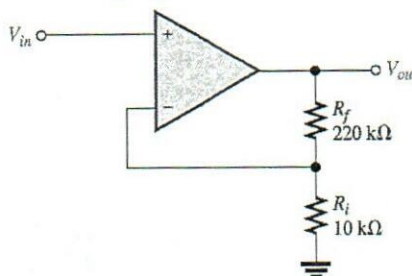
- [b]** **[i]** What is the closed-loop voltage gain of the amplifier shown in **Figure 5.1**?
[ii] If a 5V sensor output is connected to the Op-amp input and the R_f is changed to a 47k Ω resistor, what is the output voltage?

**Figure 5.1**

[c] Data sheet of the Op-amp shown in **Figure 5.2** gives $Z_{in} = 2M\Omega$, $Z_{out} = 75\Omega$, and $A_{ol} = 200k$.

[i] Calculate the input and output impedances.

[ii] Calculate the closed loop voltage gain

**Figure 5.2**

$$B = \frac{R_i}{R_i + R_f}$$

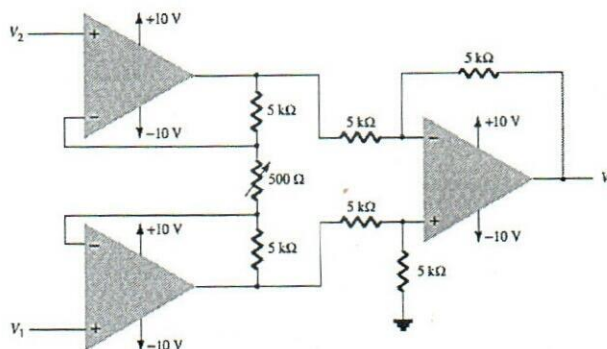
$$Z_{in(NI)} = (1 + A_{ol}B)Z_{in}$$

$$Z_{out(NI)} = \frac{Z_{out}}{1 + A_{ol}B}$$

$$A_{cl(NI)} = 1 + \frac{R_f}{R_i}$$

[d] Derive an expression for the output voltage of the instrumentation amplifier in **Figure 5.3**.

[6]

**Figure 5.3**

[e] Name three applications which utilize Op-amps.

[4]

[3]