Name of the Program: B.Sc. in EEE
Semester: 1st

Date: 28 September, 2022
Time: 10:30 am – 12:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4101
Course Title: Electrical Circuit I

Winter Semester, A. Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **3 (three)** questions. Answer **all the** questions. Question 3(a) and 3(b) have **alternatives**. Marks of each question and corresponding COs and POs are written in the brackets. Assume any data if necessary.

1(a) Calculate the power absorbed by each element in the circuit in Fig. 1 (a_1). The energy absorbed by the BOX in Fig. 1 (a_2) is shown in the graph below. Calculate and sketch the current flowing into the BOX between 0 and 10 milliseconds. [Fig. 1 (a_1) and Fig. 1 (a_2) are linked.] (13) (CO1) (PO1)

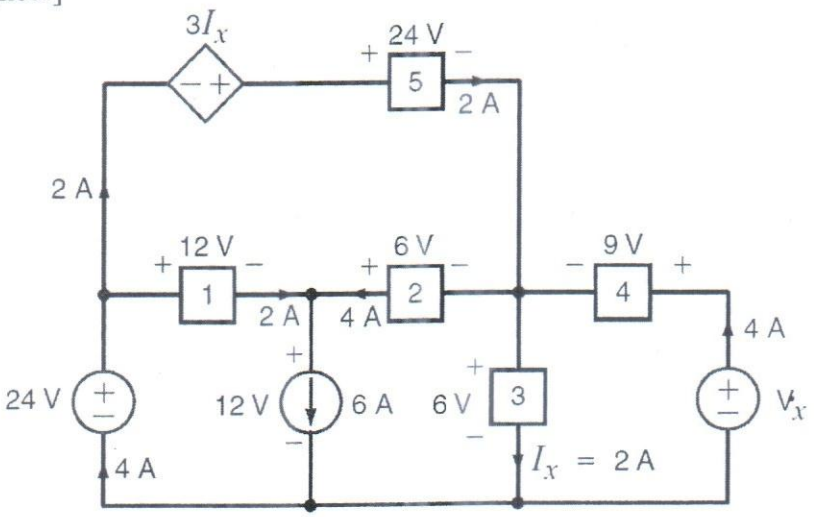


Fig. 1 (a_1)

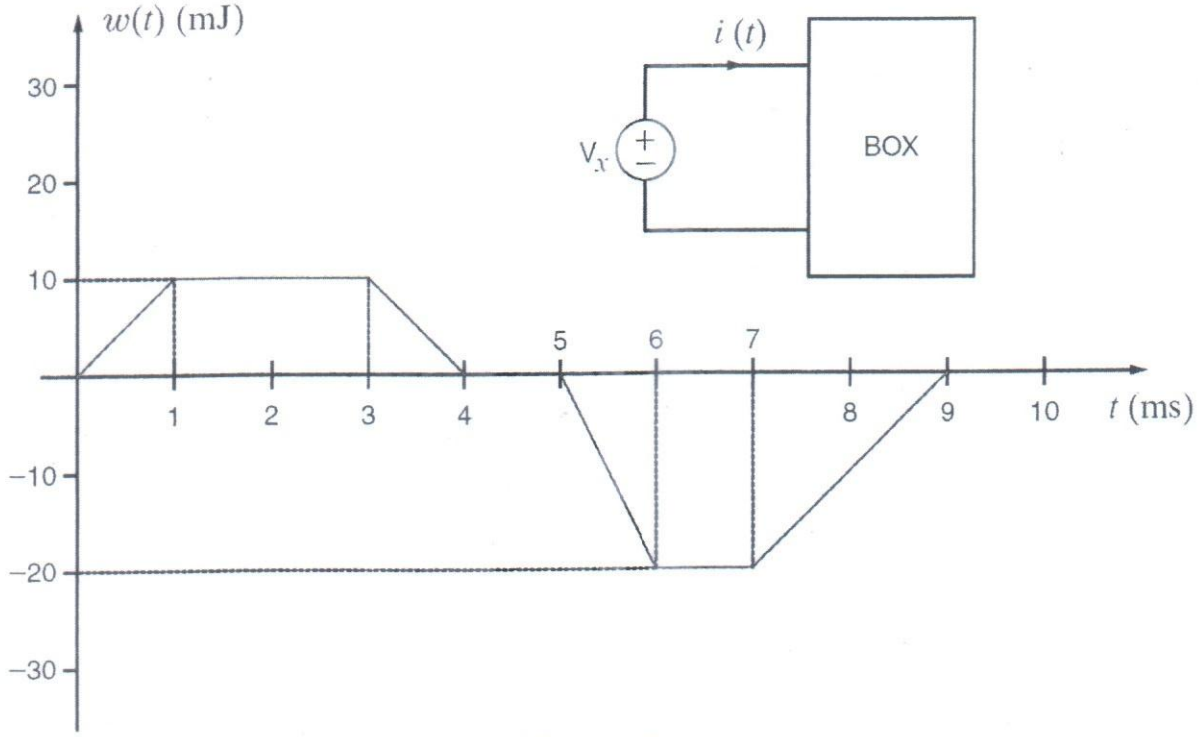


Fig. 1 (a_2)

1(b) Determine the value of V_0 in the network in Fig. 1 (b) without using any network analysis technique. (12) (CO1) (PO1)

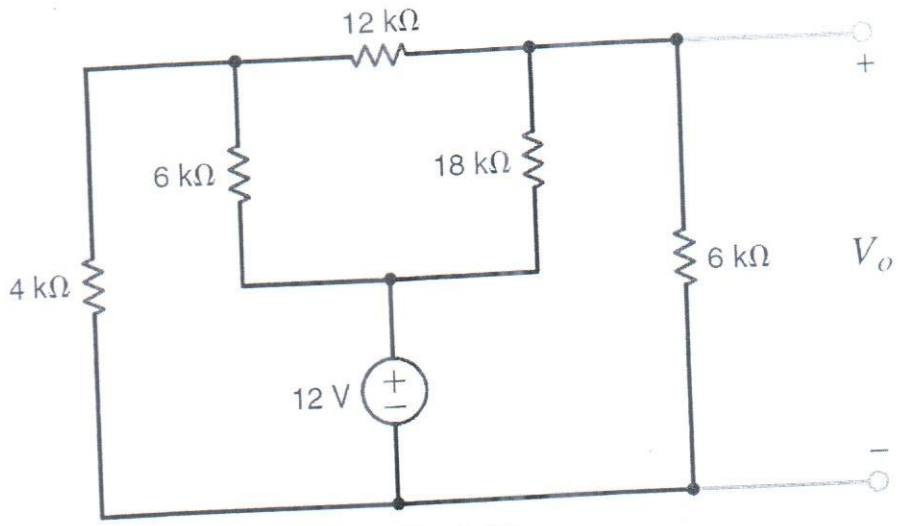


Fig. 1 (b)

2(a) Use nodal analysis to find V_0 in the network in Fig. 2 (a). (13) (CO2) (PO2)

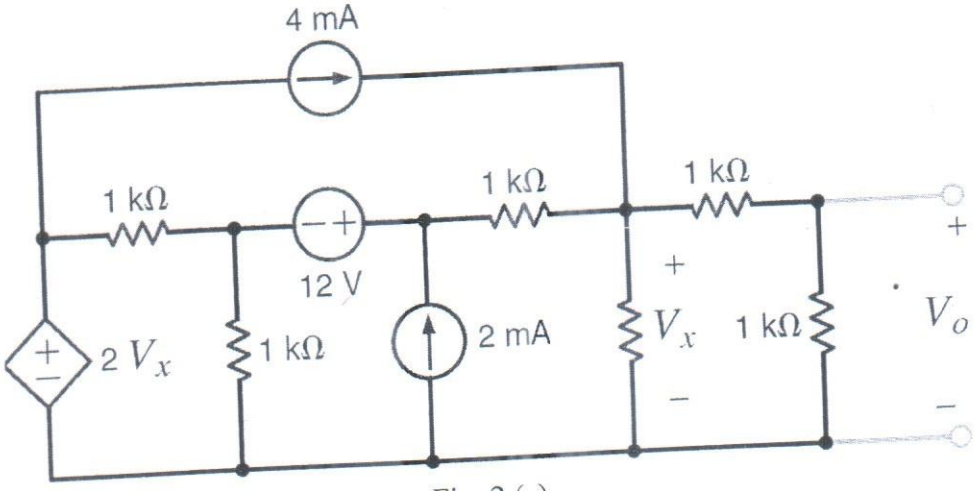


Fig. 2 (a)

2(b) Find V_0 in the circuit in Fig. 2 (b) using loop analysis. (12) (CO2) (PO2)

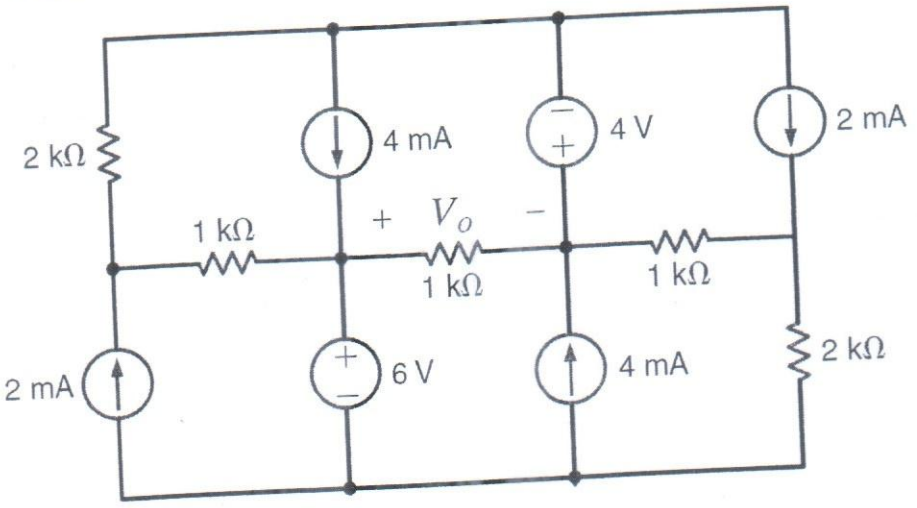


Fig. 2 (b)

3(a) Use superposition theorem to find I_0 in the network in Fig. 3 (a). (13) (CO2) (PO2)

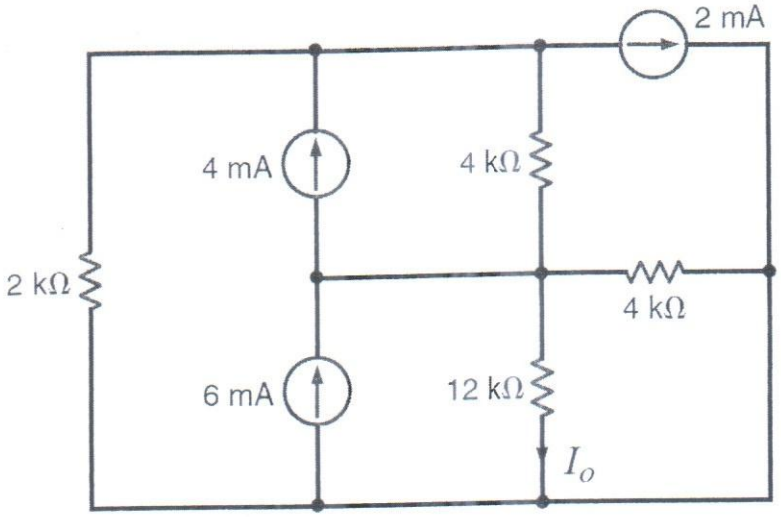


Fig. 3 (a)

3(b) Use Thévenin's theorem to find I_0 in the network in Fig. 3 (b). (12) (CO2) (PO2)

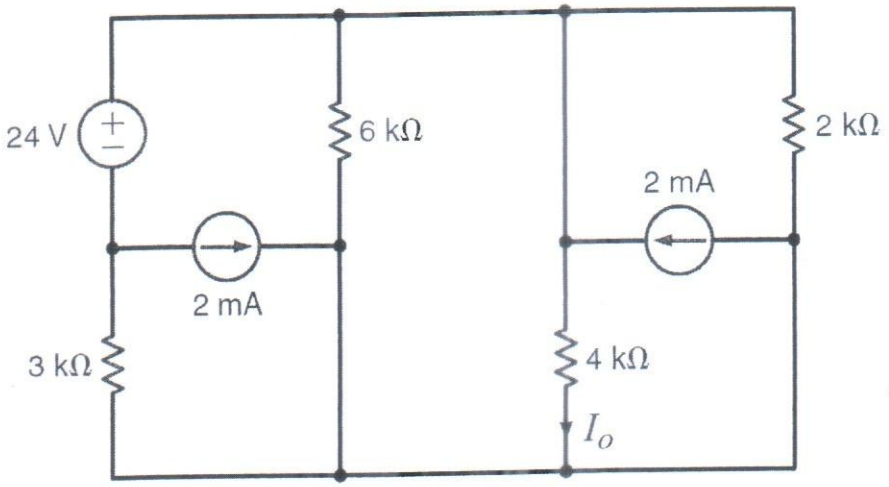
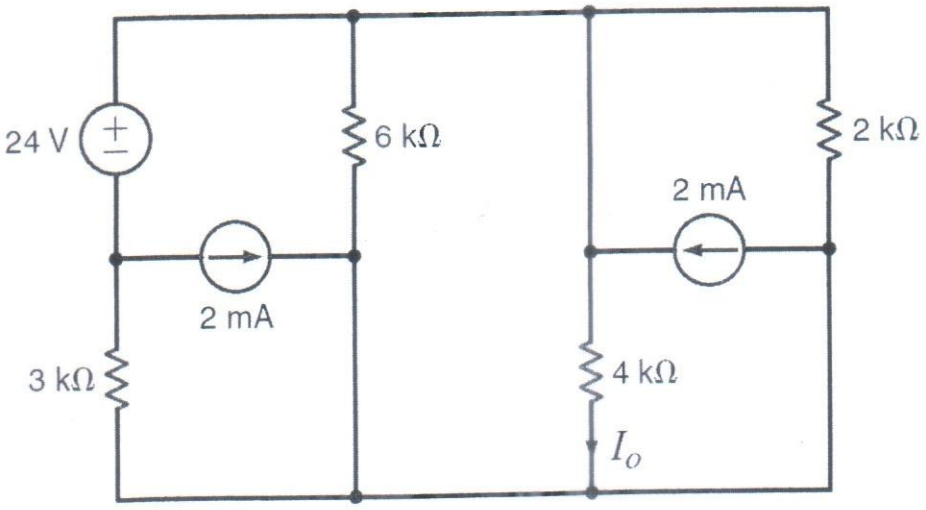


Fig. 3 (b)

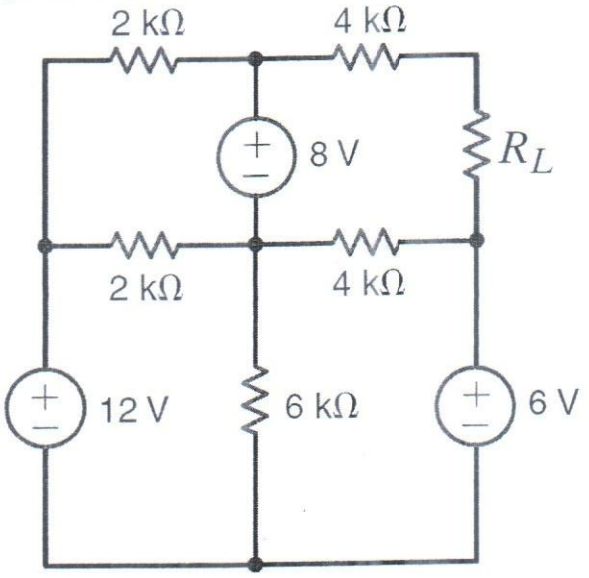
OR

3(a) Use Norton's theorem to find I_0 in the network in Fig. 3(a_OR). (13) (CO2) (PO2)



3(a_OR)

3(b) Find the value of R_L in Fig. 3(b_OR) for maximum power transfer and the maximum power that can be dissipated in R_L. (12) (CO2) (PO2)



3(b_OR)

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Name of the Program: B.Sc. in EEE
Semester: 1st

Date: 05 October, 2022
Time: 10:00 am – 11:30 am

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: Chem 4121
Course Title: Engineering Chemistry

Winter Semester, A. Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **3 (three)** questions. Answer all **3 (three)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

1	a)	Define Cp and Cv. Explain the head capacity of a reaction depends on temperature change.	7	(CO2, PO3)
	b)	Discuss Rutherford α-particle experiment and its findings. Write down the limitation of Rutherford atomic model.	8	CO3, PO2)
	c)	Apply Bohr atomic model to determine the wavelength of radiation in the emission spectrum of hydrogen atom. Calculate the wavelength of 3rd spectral line of Lyman series.	10	(CO4, PO3)
2	a)	Define hydrogen bond. Explain the factors favouring for the formation of covalent bonds.	7	(CO2, PO3)
	b)	Discuss Pauli exclusion principle and analyze whether each of the following sets of quantum numbers is permissible for an electron in an atom. Justify your answer with proper reasons.	8`	CO3, PO2)
		(i) $n = 1, l = 0, m_l = 0, m_s = +\frac{1}{2}$		
		(ii) $n = 3, l = 1, m_l = =2, m_s = =-\frac{1}{2}$		
		(iii) $n = 2, l = 1, m_l = 0, m_s = +\frac{1}{2}$		
		(iv) $n = 2, l = 0, m_l = 0, m_s = 1$		
	c)	Describe an appropriate model for predicting molecular shape. Apply this model to find out the shape of the following molecules (i) SO_2 (ii) ClF_3 (iii) XeF_6 (iv) SO_4^{2-}	10	(CO4, PO3)
3	a)	Define osmotic pressure. Explain the Van't Hoff equation of osmotic pressure.	7	(CO2, PO3)
	b)	Derive an expression relating depression of freezing point of a solution and molar mass of solute with the help of vapour pressure- temperature diagram.	8	CO3, PO2)
	c)	Describe an experimental process to measure the depression of freezing point. 6.5 g of urea (molecular mass 60) dissolved in a given amount of water lowers the freezing point by 1.2°C. the freezing point depression constant of water is 0.53. Calculate amount of water taken in this solution.	10	(CO4, PO3)

B. Sc. in EEE, 1st Sem. Date: September 30, 2022 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY(IUT)
ORGANISATION OF ISLAMIC COOPERATION(OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination — Winter Semester A.Y. 2021-2022
Course No.: Math 4121 — Full Marks: 75
Course Title: Mathematics I — Time: 90 Minutes

There are **3 (three)** questions. Answer **3 (three)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

---

1. (a) If by the rotation of axes about the origin, the expression $ax^2 + 2hxy + by^2$ changes to $a'x'^2 + 2h'x'y' + b'y'^2$ then find the invariants of transformation. **(12)** (CO1) (PO1)

(b) Differentiate $(1-x^2)y_2 - xy_1 - 2 = 0$ n times to find the relation connecting y_{n+2}, y_{n+1} and y_n. **(13)** (CO1) (PO1)

2. (a) Evaluate $Lt_{x\to 0} \dfrac{e^{2x} + e^{-2x} - 2\cos 2x}{x \sin 2x}$ **(8)** (CO2) (PO2)

(b) *If* $u = f(x^2 + 2yz,\ y^2 + 2zx)$ *then find the value of* $(y^2 - zx)\dfrac{\partial u}{\partial x} + (x^2 - yz)\dfrac{\partial u}{\partial y} + (z^2 - xy)\dfrac{\partial u}{\partial z}$ **(8)** (CO2) (PO2)

(c) Prove that the condition that $x\cos\alpha + y\sin\alpha = p$ should touch $x^m y^n = a^{m+n}$ is $p^{m+n} m^m n^n = (m+n)^{m+n} a^{m+n} \sin^n\alpha \cos^m\alpha$ **(9)** (CO2) (PO2)

3. (a) Find the radius of curvature of the curve $\sqrt{x} + \sqrt{y} = \sqrt{a}$ at the point where the line $y = 4x$ cuts it. **(12)** (CO1) (PO1)

(b) Find the altitude of the right circular cylinder of maximum volume that can be inscribed in a given right circular cone of height h. **(13)** (CO3) (PO2)

B. Sc. in EEE, 1st Sem. Date: October 4, 2022 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid Semester Examination
Course Number: Phy 4121
Course Title: Engineering Physics I

Winter Semester: 2021 - 2022
Full Marks: 75
Time: 90 Minutes

There are **6 (Six)** questions. Answer **4 (Four)** questions according to the instructions mentioned in Sec A and Sec B. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in brackets. **Q1 and Q6 are compulsory.**

Sec A
Q1 is compulsory, Answer any one from Q2 and Q3.

1. (a) Distinguish between Rutherford and Bohr's atomic models. What are the success and failures of these models? Briefly explain Rutherford's ⟨-particle scattering experiment. [8+8.5+3] (CO1, PO1)

   (b) Using the postulates of Bohr, derive an expression of the energy of an electron in the n^{th} orbit. What is ionization energy? (CO2, PO1)

   (c) Determine the value of the longest wavelength found in the Paschen series. (CO3, PO2)

2. (a) What is the fundamental building block of a material? Briefly discuss the possible arrangement of atoms in a solid. What is anisotropy? [8+8+2] (CO1, PO1)

   (b) Discuss the terms grain, grain boundary, textured crystal, and polymorphism. (CO2, PO1)

   (c) Suppose from the surface morphology of a material you observed average grain size is 5μm. Estimate the possible number of atoms in that grain. (CO3, PO2)

3. a) Briefly discuss why interatomic or intermolecular bonds exist in solids. What is the importance of bonds in solid? Explain ionic and covalent bonds. Why covalent bonds are called directional bonds? [8+8+2] (CO1, PO1)

   (b) Distinguish between cohesive energy and lattice energy. Derive an expression for lattice energy of *NaCl* crystal. (CO2, PO1)

   (c) The covalent bonding energy of *C-C* is *370 KJ/Mole*. Evaluate the wavelength of light that will break the *C-C* bond. (CO3, PO2)

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Sec B

Q6 is compulsory, Answer any one from Q4 and Q5.

4.	(a) When two light waves interfere constructively what happens to their energy?	05	CO1 PO1
	(b) How can you prove that the linear fringe separation is directly proportional to the wavelength of light?	08	CO2 PO2
	(c) Suppose that Young's experiment is performed with blue-green light of wavelength 800 nm. The slits are 1.10 mm apart, and the viewing screen is 6.40 m from the slits. How far apart are the bright fringes near the center of the interference pattern?	05	CO1 PO1
5.	(a) What are the conditions for observing bright and dark rings in Newton's ring experiment for reflected light?	03	CO1 PO1
	(b) How can you determine the wavelength of light with the help of Newton's ring experiment?	09	CO2 PO2
	(c) A Newton's rings apparatus is used to determine the radius of curvature of a lens. The radii of the n^{th} and $(n+10)^{th}$ bright rings are measured and found to be 0.182 cm and 0.368 cm, respectively, in light of wavelength 600 nm. Calculate the radius of curvature of the lower surface of the lens.	06	CO1, CO2 PO1, PO2
6.	(a) What is diffraction of light? Write down the required condition for observing diffraction.	06	CO3 PO2
	(b) What is diffraction grating? How a diffraction grating is consists of? What is its application?	07	CO3 PO2
	(c) Discuss briefly the intensity of diffraction pattern due to single slit. How critical angle is related with central maxima and first minima?	6.5	CO3 PO2

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B. Sc. in EEE, 1st Sem. Date: October 3, 2022 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY(IUT)
ORGANISATION OF ISLAMIC COOPERATION(OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: Math 4123
Course Title: Mathematics II

Winter Semester A.Y. 2021-2022
Full Marks: 75
Time: 90 Minutes

There are 4 (Four) questions. Question 1 and Question 2 are compulsory. From Question 3 or Question 4 answer any one. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The Symbols have their usual meaning

1(a) Verify that $(AB)^T = B^T A^T$, where $A = \begin{bmatrix} 1 & 1 & 5 \\ 2 & 2 & 1 \\ 4 & 3 & 2 \end{bmatrix}$ *and* $B = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 1 & 2 \\ 3 & 1 & 0 \end{bmatrix}$. **(10)** Co-1 Po-1

(b) Find the inverse of $A = \begin{bmatrix} 3 & -1 & 1 & 2 \\ 1 & 1 & 0 & 1 \\ 0 & 0 & 1 & 2 \\ 1 & 0 & 0 & 1 \end{bmatrix}$ by adjoint method. **(15)** Co-1 Po-1

2(a) Find the canonical matrix of $A = \begin{bmatrix} 4 & 8 & 12 & 16 \\ 2 & 7 & 3 & 5 \\ 6 & 16 & 2 & -4 \\ 2 & 4 & 6 & 8 \end{bmatrix}$ and hence find rank. **(13)** Co- 2 Po-1 Po-2

(b) Solve the following system of linear equations **(12)** Co-1 Po-1 Po-2

$$3x_1 - 2x_2 + 2x_3 = 1$$
$$2x_1 + 2x_2 - x_3 = 2$$
$$4x_1 + 4x_2 - 3x_3 = 6$$
$$2x_1 - x_2 - 3x_3 = 9.$$

3(a) Find the differential equation of all circles passing though origin and having their centers on the x-axis. **(8)** Co- 3 Po-1 Po-2

(b) Solve: $\frac{dy}{dx} = \sin(x+y) + \cos(x+y)$. **(8)** Co- 3 Po-1 Po-2

(c) Solve the initial value problem: $(y^2 - x + y)dy + y(y+1)dx = 0,\ y(0) = 1.$ **(9)** Co- 4 Po-1 Po-2

4(a) Solve: $\sec y \operatorname{cosec} y\,(1-x^2)\frac{dy}{dx} + x = x\cot y$. **(8)** Co-3 Po-1 Po-2

(b) Solve $\left[4xy + 3y^2 + \frac{\cos(\ln x)}{x^3}\right]dx + (x^2 + 2xy)dy = 0$. **(8)** Co- 3 Po-1 Po-2

(c) A 20 volts battery is connected to an inductance of 0.5 henry and a resistance of 10 ohms all in series. If the current is zero when t=0, find the current at end of .025 sec. **(9)** Co- 4 Po-1 Po-2

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B.Sc. Engg. (EE), 3rd Sem.
DTE, 1st Sem

Date: 03 October, 2022
Time: 02:30 pm – 04:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid Semester Examination
Course No.: EEE 4301/EEE 4395
Course Title: Power System I

Winter Semester, A.Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **3 (three)** questions. Answer **all** of them. All questions carry equal marks. Marks in the right margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. Symbol(s) preserve their usual meanings. Assume reasonable value, if it is required.

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1. a) Justify why are insulators used with overhead lines. Discuss the desirable properties of insulators. Explain various methods of improving string efficiency. [3+4+6] [CO1] [PO1]

   b) Each of the three insulators forming a string has a self capacitance of C farad. The shunt capacitance of each insulator is 0·2 C to earth and 0·1 C to line. A guard-ring increases the capacitance of line of the metal work of the lowest insulator to 0·3 C. Calculate the string efficiency of the arrangement :
   i)with the guard ring and
   ii) without guard ring. [6×2] [CO2] [PO2]

2. a) Determine the loss due to corona effect for a three-phase overhead line considering the following(s): 110 kV, 50 Hz, 150 km long transmission line consisting of three conductors each of 10 mm diameter and spaced 2·5 m apart in an equilateral triangle formation. The temperature of air is 30°C and the atmospheric pressure is 750 mm of mercury. Take irregularity factor as 0·85. Ionization of air may be assumed to take place at a maximum voltage gradient of 30 kV/cm. [8] [CO2] [PO2]

   b) A single-phase a.c. distributor AB is fed from end A and has a total impedance of (0·2 + j03) ohm. At the far end, the voltage $V_B = 240$ V and the current is 100 A at a p.f. of 0·8 lagging. At the mid-point M, a current of 100 A is tapped at a p.f. of 0·6 lagging with reference to the voltage V_M at the mid-point. Calculate
   i) the supply voltage V_A, ii) phase angle between V_A and V_B and
   iii) Sketch the complete phasor diagram mentioning all the components. [4+2+3] [CO2] [PO2]

   c) A 2-wire d.c. distributor AB 500 metres long is fed from point A and is loaded as under : [8] [CO2] [PO2]

Distance from feeding point A (in metres)	100	300	400	500
Load (amperes)	20	40	40	50

   If the specific resistance of copper is $1·7 \times 10^{-8}$ Ωm, evaluate the cross-section of each wire in order that the voltage drop in the distributor shall not exceed 10 volts ?

3. a) Design an overhead transmission line at a river crossing which is supported from two towers at heights of 50 m and 100 m above the water level. The horizontal distance between the towers is 400 m. If the maximum allowable tension is 1800 kg and the conductor weighs 1 kg/m, find the clearance between the conductor and water at a point mid-way between the supports. [10] [CO3] [PO3]

b) Design the voltage profile at each load point of a d.c. 2-wire ring main system where ABCDEA is fed from 230 V supply as shown in Fig. 3(b) and consider the resistance of each section of the d.c. 2-wire ring main system (go and return) AB, BC, CD, DE and EA as 0·1 Ω. The loads are tapped off as shown in Fig. 3(b). [15] [CO3] [PO3]

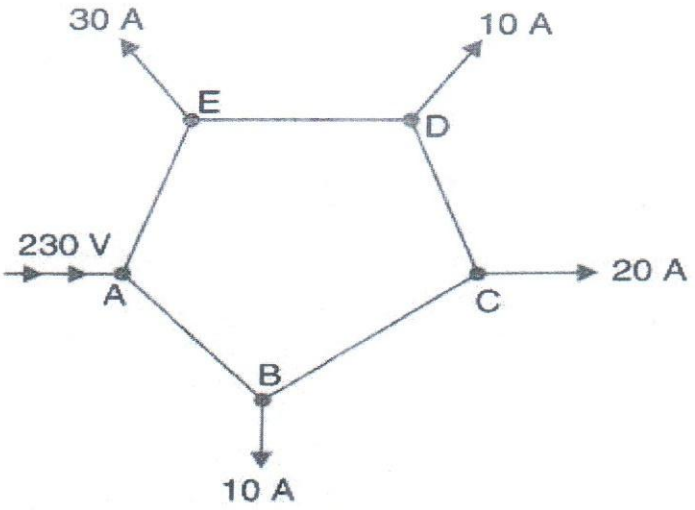

Fig. 3(b)

Name of the Program: B. Sc. in EEE
Semester: 3rd Semester

Date: 29 September, 2022
Time: 02:30pm – 04:00pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course Number: EEE 4303
Course Title: Electronics II

Winter Semester: 2021 - 2022
Full Marks: 75
Time: 90 Minutes

There are **03 (three)** questions. Answer **all** the questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

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1. a) Explain the inverting amplifier which is used as a voltage-to-current converter and show that the load current i_L is proportional to the input voltage v_i and is independent of the load impedance Z_L. **(12.5) (CO1) (PO1)**

b) Evaluate a summing op-amp to produce the output $v_0 = -10v_{I1} - 4v_{I2} + 5v_{I3} + 2v_{I4}$. The smallest resistor value allowable is 20 kΩ. **(12.5) (CO2) (PO2)**

2. a) Sketch the Bode plots (magnitude & phase) for the transfer function, $H(\omega) = \frac{5(j\omega+2)}{j\omega(j\omega+10)}$. **(12.5) (CO1) (PO1)**

b) Analyse the Bode plot in Fig. 2(b) and find the transfer function $H(\omega)$. **(12.5) (CO2) (PO2)**

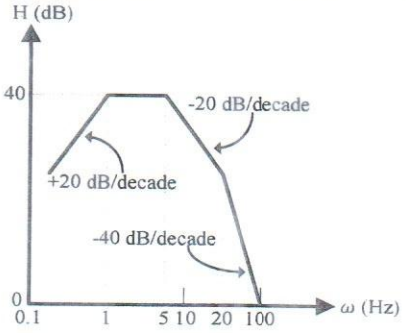

Fig. 2(b)

3. a) Briefly explain a precision half-wave rectifier and an exponential amplifier using an op-amp and a diode. **(12.5) (CO1) (PO1)**

b) Formulate a single-pole high-pass filter with a gain of 8 in the passband and a 3 dB frequency of 30 kHz. The maximum resistance is to be 210 kΩ. **(12.5) (CO2) (PO2)**

B.Sc. Engg. EE, 3rd Sem.
DTE, 1st Sem.

Date: September 28, 2022
Time: 2:30 pm to 4:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid Semester Examination
Course No.: EEE 4305/EEE 4391
Course Title: Energy Conversion I

Winter Semester, A.Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **3 (three)** questions. Answer **all 3 (three)** questions. Marks, corresponding POs, and corresponding COs have been written in brackets on the right. Programmable calculators are not allowed. Do not write on this question paper. Assume suitable values for any missing data.

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1. a) A short–shunt compound–wound dc generator supplies a full–load current of 100 A at a voltage of 220 V. The resistance of the armature is 0.005 Ω, of shunt field is 50 Ω, and of series field is 0.025 Ω. The total brush drop is 2 V and the iron and friction losses amount to 1 kW. Solve for: (10) (PO1) (CO1)
   i) The generated emf,
   ii) The copper losses,
   iii) The output power of the prime–mover driving the generator, and
   iv) The generator efficiency.

   b) A linear dc machine started its operation at $t = 1\ s$, reached the steady–state at $t = 5\ s$, started operating as a generator at $t = 8\ s$, and reached steady–state as a generator at $t = 12\ s$. In a normal graph paper, sketch the response curves for: (04) (PO1) (CO1)
   i) $v(t)$,
   ii) $i(t)$,
   iii) $F_{ind}(t)$, and
   iv) $e_{ind}(t)$.
   Assume suitable values for any relevant data.

   c) Illustrate the operation of a commutator consisting of two semi–circular segments and two fixed contacts connected to the external circuit of the simple rotating loop generator with appropriate circuit diagrams. (04) (PO1) (CO1)

   d) Justify the statement that "calculations of flux in a ferromagnetic core performed by using magnetic circuit concepts are at best, accurate to within 5% of real answer." (04) (PO1) (CO1)

   e) Explain the significance of operating different dc machines at different regions of the magnetization curve of the ferromagnetic core of that particular dc machine. (04) (PO1) (CO1)

   f) Interpret the principles of manipulation of magnetic field to produce different machine actions in converting energy from one form to another. (04) (PO1) (CO1)

2. a) For a 2–pole, lap–wound, simplex dc generator, assess the interactions of different fluxes produced and summarize the changes observed in the following parameters: (15) (PO2) (CO2)
   i) Distribution of the field/main flux,
   ii) Distribution of the armature flux,
   iii) Magnetic neutral axis (MNA),
   iv) Geometric Neutral Axis (GNA),
   v) Position of the brushes, and
   vi) Vector diagrams of the mmf produced.

   b) A dc generator with ring winding consists of coils A, B, C, D, E, F, G, and H. The coil D is going through commutation. Each coil has 4 turns and carries 20 *A* current. Assess the process of commutation and summarize the followings with appropriate sketches: (10) (PO2) (CO2)
   i) Beginning stage of the commutation,
   ii) Intermediate stages of the commutation,
   iii) Concluding stage of the commutation,
   iv) Size of the brush, and
   v) Changes in the current through the coil D.

   c) For a dc generator, summarize the percentage contributions and corresponding equations for calculating each type of loss heads encountered in its operation. (05) (PO2) (CO2)

3. For a 4–pole dc generator with lap–wound duplex winding consisting of 11 coils, design for the followings: (15) (PO3) (CO3)
   i) Appropriate winding parameter values,
   ii) Back and front conductor connections,
   iii) A developed winding diagram,
   iv) Appropriate equalizing connections, and
   v) Appropriate brush positions.

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Name of the Program: B.Sc. in EEE
Semester: Winter

Date: 04 October, 2022
Time: 02:30 pm – 04:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4307
Course Title: Digital Electronics

Winter Semester, A. Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **3 (three)** questions. Answer all **3 (three)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets. Do not write on the question paper.

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1 (a) The (r-1)'s complement of base-7 numbers is called the 6's complement. **(10)**
(i) Obtain 6's complement of $(346205)_7$. **(CO1)**
(ii) Perform subtraction operation $(63524)_7 - (643210)_7$ by taking (r-1)'s complement of the subtrahend. **(PO1)**

(b) Simplify the following expressions using Algebraic method to a minimum number of literals: **(8)**
F (A,B,C) = ABC + A' + AB'C **(CO1)** **(PO1)**

(c) Construct an S-R latch using NOR gates only. Show the Function table for all possible inputs. **(7)** **(CO1)** **(PO1)**

2 (a) Design a Full-Adder using two-level NAND gates. **(5)** **(CO2)** **(PO2)**

(b) Design an adder that is capable to add four following 4-bit binary numbers $A = A_3A_2A_1A_0$, $B = B_3B_2B_1B_0$, $C = C_3C_2C_1C_0$ and $D = D_3D_2D_1D_0$. **(15)** **(CO3)**
Hint: You may use the Full-Adder Block that you have designed in question 2(a). **(PO2)**

(c) Design an 8 × 3 encoder and an 8 to 1 line multiplexer (MUX). **(10)** **(CO2)** **(PO2)**

3 Design a combinational circuit with two inputs, x and y and four outputs A, B, C, and D with the following conditions: **(20)** **(CO3)** **(PO2)**

(i) When the binary value of the input is 0 ($x = 0, y = 0$), the output should be the binary value of the last digit of your student ID.
(ii) When the binary value of the input is 1 ($x = 0, y = 1$), the output should be the 1's complement of the output you get in (i).
(iii) When the binary value of the input is 2 ($x = 1, y = 0$), the binary output should be one greater than the binary value of the last digit of your student ID.
(iv) When the binary value of the input is 3 ($x = 1, y = 1$), the binary output should be the excess-3 code of the binary value of the last digit of your student ID.

(Hint: If your student ID is 200021WXY, Y is the last digit of your student ID)

B.Sc. Engg. (EEE)/3rd Sem. 05 October, 2022
Time: 2.30pm -4.00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

TERM: MID SEMESTER EXAMINATION — WINTER SEMESTER: 2021-2022
COURSE NO.: Math 4321 — TIME: 90 Minutes
COURSE TITLE: Transform Techniques and Linear Algebra — FULL MARKS:75

There are 4 (Four) questions. Answer any 3 (Three) questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The Symbols have their usual meaning

1.(a) State Laplace transformation and write its application. (5) CO1

(b) Find $L[t^2e^t \sin 4t]$ and hence evaluate $\int_0^\infty t^2e^t \sin 4t \; dt$. (10) CO2

(c) If $L[f(t) = F(s)]$, then prove that $L\left[\frac{1}{t}f(t)\right] = \int_0^\infty F(s)ds$ and use this to find $L\left[\frac{\sin 2t}{t}\right]$. (10) CO3

2.(a) Describe the periodic function in Laplace transform. (5) CO1

(b) Find the Laplace transform of the periodic function: (10) CO2

$$f(t) = \begin{cases} \sin \omega t & \text{for } 0 < t < \frac{\pi}{\omega} \\ 0 & \text{for } \frac{\pi}{\omega} < t < \frac{2\pi}{\omega}. \end{cases}$$

(c) Find the inverse Laplace transforms of $\frac{1}{s^2-5s+6}$. Using the Laplace transforms, find the solution of the initial value problem: (10) CO3

$$y'' + y = \sin 3t, \qquad y(0) = 0, \qquad y'(0) = 0.$$

3. (a) Define periodic function. Give an example of a periodic function with graphical representation. (5) CO1

(b) Write down the Fourier series with Fourier coefficients a_0, a_n, b_n. Determine the Fourier coefficients a_0, a_n, b_n. (10) CO2

(c) Find the Fourier series expansion of the periodic function of period 2π, defined by (10) CO3

$$f(x) = \begin{cases} x, & -\frac{\pi}{2} < x < \frac{\pi}{2} \\ \pi - x, & \frac{\pi}{2} < x < \frac{3\pi}{2} \end{cases}.$$

4. (a) Define even and odd functions. Give examples of even and odd functions with graphical representation. (5) CO1

(b) Find a Fourier cosine series for the function $f(x) = e^x$ for $0 < x < \pi$. (10) CO2

(c) A machine completes its cycle of operations every time as a certain pulley completes a revolution. The displacement $f(x)$ of a point on a certain portion of the machine is given in the table given below for twelve positions of the pulley, x being the angle in degree turned through by the pulley. Find a Fourier series to represent $f(x)$ for all values of x: (10) CO3

x	30^0	60^0	90^0	120^0	150^0	180^0	210^0	240^0	270^0	300^0	330^0	360^0
$f(x)$	7.976	8.026	7.204	5.676	3.674	1.764	0.552	0.262	0.904	2.492	4.736	6.824

(80)

Program: B. Sc. in EEE
Semester: 3rd

Date: 30 September, 2022
Time: 2:30 p.m. – 4:00 p.m.

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid Semester Examination
Course Number: MCE 4391
Course Title: Basic Mechanical Engineering (EEE)

Winter Semester: 2021 - 2022
Full Marks: 75
Time: 1 Hour 30 Mins

There are **three** questions. Answer **all the** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written on the right side. Assume reasonable value of missing data.

---

1. a. (i) Illustrate 'Bomb Calorimeter' and explain how to calculate HCV and LCV from using the device. **15+5+5 =25 CO1 PO2**

(ii) The following data were recorded during an experiment to find the calorific value of a sample of coal.

a. Mass of coal burnt = 1 g
b. Mass of water in the calorimeter = 1020 g
c. Water equivalent of the calorimeter = 170 g
d. Initial temperature of water = 23.3^0C
e. Final temperature of water = 26.2^0C

Determine the higher calorific value of the sample of the coal. If the fuel used contains 8% of hydrogen, calculate its lower calorific value as well.

b. A sample of coal has the following composition by mass:
Carbon 75%; hydrogen 6%; oxygen 8%; nitrogen 2.5%; Sulphur 1.5%: and ash 7%. Calculate its higher and lower calorific values per kg of coal using Dulong's formula.

c. Identify the merits and demerits of gaseous fuel? Explain the requirements of a good fuel?

2. a. What are the limitations of first law of thermodynamics? State the Kelvin-Plank and Clausius statement of second law of thermodynamics? **5+20 =25 CO2 PO2**

b. An ideal Otto cycle has a compression ratio of 8. At the beginning of the compression process, air is at 95 kPa and 27^0 C, and 750 kJ/kg of heat is transferred to air during the constant-volume heat-addition process. [C_p=0.9987 kJ/kg. K, C_v=0.707 kJ/kg. K]

(i) Find pressure at all points.
(ii) Find temperature at all points.
(iii) Determine the amount of heat rejected per kg of fuel to the environment.
(iv) Determine the net-work output per kg of fuel.
(v) Find the thermal efficiency of the cycle.

If the compression ratio was changed to 12 what would be the new thermal efficiency of the cycle.

3. a. (i) Illustrate and explain the sequence of operation of four stroke SI engine and identify the key differences of this type of engine with CI engine. **(7+5+3) + (4+6) =25 CO3 PO1**
(ii) Demonstrate a side-by-side comparison of the indicator diagram of SI and CI engine.
(iii) Explain the consequences, if diesel is used in a petrol engine and petrol in a diesel engine? Explain in briefly.

b. (i) State the differences between 2 stroke engine and 4 stroke engine.
(ii) State the differences between Diesel and Petrol Engine.

(82)

Name of the Program: B.Sc. Engg. (EE)

Semester: 5th

Date : September 28, 2022

Time: 10:30 AM – 12:00 PM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination Winter Semester, A.Y. 2021-2022
Course No.: EEE 4501 **Full Marks:** 75
Course Title: Electromagnetic Fields and Waves **Time:** 90 Minutes

There are 03 **(three)** questions. Answer all 03 **(three)** questions. Marks for parts of the questions and corresponding CO and PO are indicated in the right margin. Programmable calculators are not allowed. Do not write on this question paper. Symbols carry their usual meanings.

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1. a) Explain divergence and curl of a vector. Write the general mathematical equations (not coordinate specific equations) of these quantities. Also, state and explain Stokes's theorem. **(10+5) (CO1) (PO1)**

b) Calculate the total outward flux of vector **(10+5) (CO2) (PO2)**

$$\mathbf{F} = \rho^2 \sin\phi\, \mathbf{a}_\rho + z\cos\phi\, \mathbf{a}_\phi + \rho z\, \mathbf{a}_z$$

through the hollow cylinder defined by $2 \le \rho \le 3$, $0 \le z \le 5$.

2. a) Spherical surfaces $r = 1$ m and $r = 3$ m carry uniform surface charge densities 6 mC/m^2 and –6 mC/m^2, respectively. Find **D** at $r = 2$ m and $r = 4$ m. **(10+5) (CO3) (PO2)**

b) A circular ring of charge of radius a lies in the x–y plane and is centered at the origin. The ring is in air and carries a uniform charge density ρ_l. **(10+5) (CO3) (PO2)**

(i) Obtain an expression for the electric potential V at a point (0, 0, z) on the z axis.
Use the general expression of V for line charge -

$$V(\mathbf{r}) = \frac{1}{4\pi\varepsilon_o}\int_L \frac{\rho_L(\mathbf{r}')dl'}{|\mathbf{r}-\mathbf{r}'|}$$

(ii) Find the corresponding electric field **E**.

3. Region 1 is $x < 0$ with $\varepsilon_1 = 4\varepsilon_0$, while region 2 is $x > 0$ with $\varepsilon_2 = 2\varepsilon_0$. If $\mathbf{E}_2 = 6\mathbf{a}_x - 10\mathbf{a}_y + 8\mathbf{a}_z$ V/m, find (i) $\mathbf{P}_1$, (ii) $\mathbf{P}_2$ and (iii) energy density in region 1. **(5+5+5) (CO3) (PO2)**

VECTOR DERIVATIVES

Cartesian Coordinates (x, y, z)

$$\mathbf{A} = A_x\mathbf{a}_x + A_y\mathbf{a}_y + A_z\mathbf{a}_z$$

$$\nabla V = \frac{\partial V}{\partial x}\mathbf{a}_x + \frac{\partial V}{\partial y}\mathbf{a}_y + \frac{\partial V}{\partial z}\mathbf{a}_z$$

$$\nabla \cdot \mathbf{A} = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$$

$$\nabla \times \mathbf{A} = \begin{vmatrix} \mathbf{a}_x & \mathbf{a}_y & \mathbf{a}_z \\ \dfrac{\partial}{\partial x} & \dfrac{\partial}{\partial y} & \dfrac{\partial}{\partial z} \\ A_x & A_y & A_z \end{vmatrix}$$

$$= \left[\frac{\partial A_z}{\partial y} - \frac{\partial A_y}{\partial z}\right]\mathbf{a}_x + \left[\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x}\right]\mathbf{a}_y + \left[\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y}\right]\mathbf{a}_z$$

$$\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$$

Cylindrical Coordinates (ρ, ϕ, z)

$$\mathbf{A} = A_\rho\mathbf{a}_\rho + A_\phi\mathbf{a}_\phi + A_z\mathbf{a}_z$$

$$\nabla V = \frac{\partial V}{\partial \rho}\mathbf{a}_\rho + \frac{1}{\rho}\frac{\partial V}{\partial \phi}\mathbf{a}_\phi + \frac{\partial V}{\partial z}\mathbf{a}_z$$

$$\nabla \cdot \mathbf{A} = \frac{1}{\rho}\frac{\partial}{\partial \rho}(\rho A_\rho) + \frac{1}{\rho}\frac{\partial A_\phi}{\partial \phi} + \frac{\partial A_z}{\partial z}$$

$$\nabla \times \mathbf{A} = \frac{1}{\rho}\begin{vmatrix} \mathbf{a}_\rho & \rho\mathbf{a}_\phi & \mathbf{a}_z \\ \dfrac{\partial}{\partial \rho} & \dfrac{\partial}{\partial \phi} & \dfrac{\partial}{\partial z} \\ A_\rho & \rho A_\phi & A_z \end{vmatrix}$$

$$= \left[\frac{1}{\rho}\frac{\partial A_z}{\partial \phi} - \frac{\partial A_\phi}{\partial z}\right]\mathbf{a}_\rho + \left[\frac{\partial A_\rho}{\partial z} - \frac{\partial A_z}{\partial \rho}\right]\mathbf{a}_\phi + \frac{1}{\rho}\left[\frac{\partial}{\partial \rho}(\rho A_\phi) - \frac{\partial A_\rho}{\partial \phi}\right]\mathbf{a}_z$$

$$\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho\frac{\partial V}{\partial \rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial \phi^2} + \frac{\partial^2 V}{\partial z^2}$$

Spherical Coordinates (r, θ, ϕ)

$$\mathbf{A} = A_r\mathbf{a}_r + A_\theta\mathbf{a}_\theta + A_\phi\mathbf{a}_\phi$$

$$\nabla V = \frac{\partial V}{\partial r}\mathbf{a}_r + \frac{1}{r}\frac{\partial V}{\partial \theta}\mathbf{a}_\theta + \frac{1}{r\sin\theta}\frac{\partial V}{\partial \phi}\mathbf{a}_\phi$$

$$\nabla \cdot \mathbf{A} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 A_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(A_\theta \sin\theta) + \frac{1}{r\sin\theta}\frac{\partial A_\phi}{\partial \phi}$$

$$\nabla \times \mathbf{A} = \frac{1}{r^2\sin\theta}\begin{vmatrix} \mathbf{a}_r & r\mathbf{a}_\theta & (r\sin\theta)\,\mathbf{a}_\phi \\ \dfrac{\partial}{\partial r} & \dfrac{\partial}{\partial \theta} & \dfrac{\partial}{\partial \phi} \\ A_r & rA_\theta & (r\sin\theta)\,A_\phi \end{vmatrix}$$

$$= \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial \theta}(A_\phi \sin\theta) - \frac{\partial A_\theta}{\partial \phi}\right]\mathbf{a}_r + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial A_r}{\partial \phi} - \frac{\partial}{\partial r}(rA_\phi)\right]\mathbf{a}_\theta$$

$$+ \frac{1}{r}\left[\frac{\partial}{\partial r}(rA_\theta) - \frac{\partial A_r}{\partial \theta}\right]\mathbf{a}_\phi$$

$$\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial V}{\partial \theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial \phi^2}$$

B.Sc. Engg. (EE) / HDEE (5th Semester)
B.Sc. TE (2-Yr) (1st Semester)

Date: September 30, 2022 (Morning)
Time: 10:30 AM-12:00 PM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4503
Course Title: Power Electronics

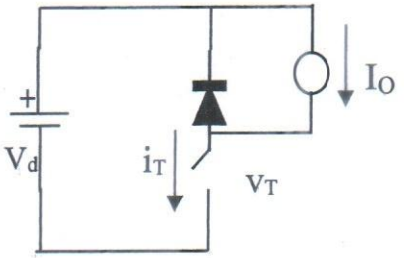
Winter Semester, A. Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

Marks in the margin indicate full marks. Do not write on this question paper. Assume reasonable value for any missing data and assume that the power devices are ideal.

---

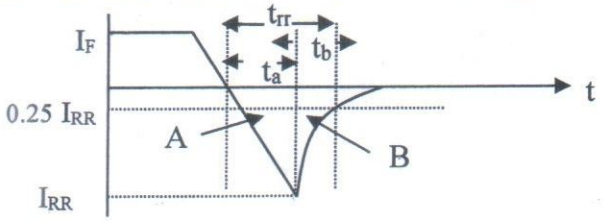
1. a) With the help of a block diagram, explain how a power electronic system meets the demand of the users. Justify whether a power electronic system be replaced by a linear electronic system to convert high power conversion. — 10 CO1 PO1

b) The data sheets of a switching device specify the following switching times corresponding to the linearized switching characteristics for clamped-inductive switching: t_{ri}=100 ns, t_{fv}=50 ns, t_{rv}=100ns, t_{fi}=200 ns. Calculate and depict the switching power loss as a function of frequency in a range of 25 to 100 kHz. Assume V_d=400 volt, I_O=6 amp in the following circuit: — 08 CO2 PO2



Comment on the switching power loss of the on-state and off-state of the power electronic switch. If the switching power loss increases with the switching frequency, discuss the trade-off that need to be considered for efficient switching operation.

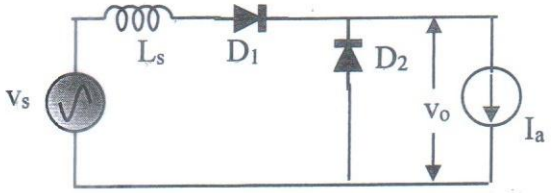
c) (i) State why the reverse recovery characteristic of a semiconductor device considered so important. (ii) Following is a reverse recovery characteristic of a semiconductor device whose data are as follows: Area, A= 150 amp-μs, area B= 120 amp-μs, di/dt=40A/μs. Find (i) I_{RR} and (ii) the reverse recovery time, t_{rr}. — 07 CO1 PO1



2. a) With proper diagram, explain why line current is more distorted in an full bridge uncontrolled ac to dc converter without a finite source than that of the converter with finite value of source inductance for a highly inductive load. Calculate the loss of output voltage due to source inductance of a single phase ac to dc converter for a highly inductive load with a sinusoid input. — 08 CO1 PO1

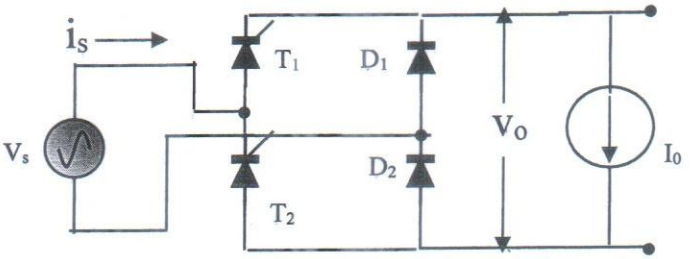
b) A single phase full bridge rectifier that supplies a very high inductive load with a constant load current of 10 A .The input voltage is 380 sin ωt. Determine (i) the THD of the source current; (ii) the input PF of the rectifier and (iii) the dc output power. — 08 CO2 PO2

c) Sketch (i) the output voltage wave-shape and calculate (ii) the commutation angle and (iii) the average output voltage of the following circuit. Following data are given: The input is sinusoidal with rms voltage of 220 V, frequency=50 Hz, L_s=10mH, I_a=15A. — 09 CO2 PO2



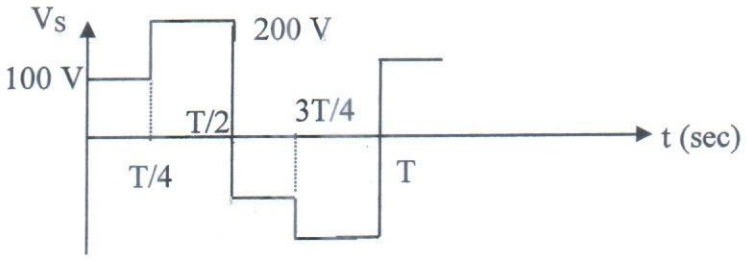
3. a) "A full bridge rectifier with a source inductance for a highly inductive load provides less output voltage than that of a rectifier without source inductance"-Justify the statement with proper circuit diagram including wave-shapes of input voltage, input current and output voltage with mathematical expressions (the input is sinusoidal). — 12 CO1 PO1

b) Illustrate v_s, i_s,and v_o waveforms and identify the devices conducting for various intervals for $\alpha=30^o$ for the following converter where input is sinisoidal. Find the input power factor? — 13 CO2 PO2

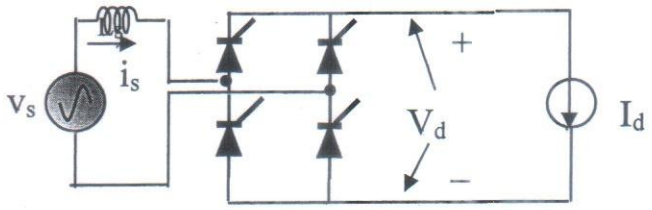


OR

3. a) A single phase bridge diode rectifier with a finite source inductance L_S=5 mH has a load of constant current of 10 amp. It has a frequency of 50 Hz. The input voltage has the wave-shape shown in the following figure. (i) Depict the wave shapes of source current and output voltage; (ii) calculating the commutation angle and average value of the output voltage, explain why there could be loss in output voltage. — 12 CO1 PO1



b) For a full bridge controlled rectifier as shown below, source has an inductance L_S of 5% with rated voltage of 230 V at 50 Hz and the rated VA of 5 KVA. Calculate the commutation angle u and average value of the output voltage for the power of 3 kW and $\alpha=30^0$. — 13 CO2 PO2



(86)

Name of the Program: B. Sc. in EEE
Semester: 5th

Date: 03 October, 2022 (Morning)
Time: 10:30 AM – 12:00 PM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course Number: Math 4521
Course Title: Numerical Methods

Winter Semester: A.Y. 2021 - 2022
Full Marks: 75
Time : 1.5 hours

There are **03 (Three)** questions. Answer **all** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets

---

1. a) The diode circuit in Fig. 1(a) below has Vs = 10 V. The emission coefficient of the diode is 1.84, the thermal voltage V_T = 25.8 mV and the leakage current $I_s = 2.862 \times 10^{-9}$ A. Find the Q-point of the circuit by solving the equation $\frac{V_s - V_D}{R_L} = I_s(e^{\frac{V_D}{\eta V_T}} - 1)$ using Newton Raphson method with an initial value of V_D = 0.7 V. Estimate the error at each iteration. Show four iterations. **(13) (CO1) (PO1)**

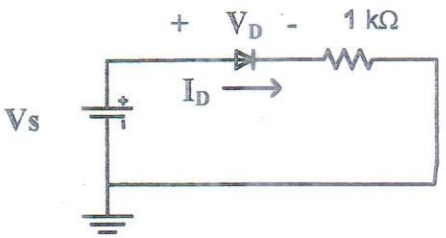


Fig. 1(a)

b) Find the first positive root of $f(x) = \sin(x) + \cos(1 + x^2) - 1$, where x is in radian. Use four iterations of the secant method with initial guesses of $x_{i-1} = 1.0$ and $x_i = 3$. **(12) (CO1) (PO1)**

2. a) How are errors of numerical method estimated? For a force free circuit, $i(t)$ is the solution of the ODE $\frac{di(t)}{dt} + 10i(t) = 0$. With $i(0) = 1.5\ A$, estimate the value of $i(0.05)$ using quadratic approximation of Taylor series. Also find the true percent of relative error by comparing the value with the exact solution. **(12) (CO2) (PO2)**

b) Determine the mesh currents in circuit of Fig. 2(b) using Gauss-Seidel method with an initial gauze of zero. Show four iterations. (13) (CO2) (PO2)

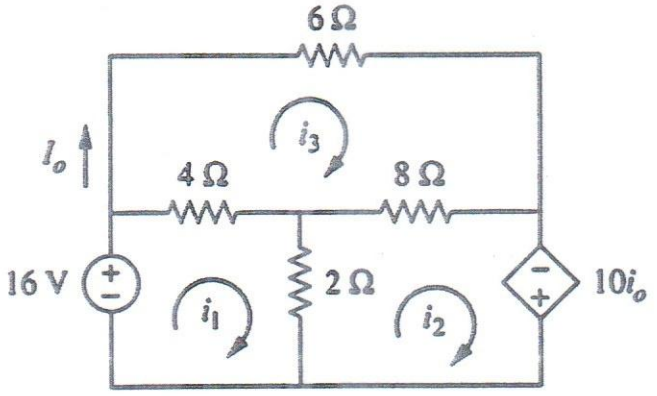


Fig. 2(b)

3. a) Compare the performance of different root finding methods (close and open) in terms of the convergence. (5) (CO3) (PO2)

b) Estimate the least number significant figures to be present in the result of a numerical estimation with an error bound of 0.001%. (5) (CO3) (PO2)

c) How many numbers of iterations are needed in a bisection method with starting $x_L = 5$ and $x_U = 3$ and the desired error is 0.0125. (5) (CO3) (PO2)

d) Describe the decomposition and substitution processes of LU decomposition. (5) (CO1) (PO1)

e) Discuss the difference between False Position method and Secant method. Explain why Secant method is introduced. (5) (CO2) (PO2)

Program: B. Sc. Engg. (EEE)
Semester: 5th

Date: 05 October 2022
Time: 10.30 a.m. to 12.00 p.m.

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid-Semester Examination
Course Number: Hum 4521
Course Title: Engineering Management

Winter Semester: 2021 - 2022
Full Marks: 75
Time: 1 Hour 30 Minutes

There are **3 (Three)** Questions. Answer **all the** Questions. The symbols have their usual meanings. Marks of each Question and corresponding CO and PO are written in brackets. Assume reasonable values, if required.

---

1. (a) What are the seven features of Bureaucracy according to Max Weber? Describe briefly McGregor's X-theory and Y-theory management systems in terms of their principles and characteristics. **(10)** (CO1) (PO1)

(b) What are the typical operation decisions involving that can have an impact on cost or profit? Explain. **(05)** (CO1) (PO1)

(c) What do you mean by value addition? Explain with an example. Also, discuss the Feedback control system in the transformation process with a suitable example. **(05)** (CO1) (PO1)

2. (a) Briefly illustrate four management functions from an engineering point of view. Also, analyze the circular management structure with its advantage and disadvantage. **(10)** (CO2) (PO2)

(b) How do you illustrate the processes "How to get ready to instruct" and "How to instruct" in the case of job instruction? **(08)** (CO2) (PO2)

(c) Which method of qualitative forecasting is suitable for getting a true opinion? Explain the method in detail. Also, discuss the consequences of over forecasting in any business organization. **(05)** (CO2) (PO2)

3. (a) A firm can produce three types of cloth, say A, B and C. Three kinds of wool are required for it, say, red wool, green wool and blue wool. One-unit length of Type A cloth needs 2 yards of red wool and 3 yards of blue wool; one-unit length of **(06)** (CO3) (PO4)

type B cloth needs 3 yards of red wool, 2 yards of green wool and 2 yards of blue wool; and one-unit length of type C cloth needs 5 yards of green wool and 4 yards of blue wool. The firm has a stock of only 8 yards of red wool, 10 yards of green wool and 15 yards of blue wool. It is assumed that the income obtained from one-unit length of type A cloth is Tk. 3, of type B Tk. 5 and that of type C cloth is Tk. 4. Formulate the problem as a linear programming problem.

(b) Objective function: **(13)**

Maximize $Z = x1 + 0.5x2$ (CO3)

Constraints: (PO4)

$3x1 + 2x2 \leq 12$

$5x1 \leq 10$

$x1 + x2 \leq 8$

$-x1 + x2 \geq 4$

$x1, x2 \geq 0$

i) Find the feasible area by Graphical Method

ii) Find the optimum value of X1 and X2.

iii) Find maximum profit

iv) Find the range of optimality for X1 and X2 separately.

(c) The historical data for the product is **(13)**

(CO3)

(PO4)

Month	Demand
January	12
February	11
March	15
April	12
May	16
June	15

i) Using a weighted moving average with weights of 0.60 for June, 0.30 for May, and 0.10 for April, find the July forecast.

ii) Using a simple three-month moving average, find the July forecast.

iii) Using exponential smoothing with $\alpha = 0.2$ and a June forecast = 13, find the July forecast.

iv) Using simple linear regression analysis, calculate the regression equation for the preceding demand data.

v) Using the regression equation in (iv), calculate the forecast for July.

(90)

Name of the Program: B.Sc.Engg (EE), 5th Sem, B.Sc. TE (2-Yr), 1st Sem.
Semester: Winter

Date: 29 September, 2022
Time: 10:30am – 12:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course Number: EEE 4521/ EEE 4797
Course Title: Power System Protection I

Winter Semester: 2021 – 2022
Full Marks: 75
Time: 1 Hour and 30 Minutes

There are **03 (three)** questions. Answer **03 (three)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

---

1 a) Differentiate between relay with make type contact and relay with break time with necessary diagrams. Illustrate how the operation of these two types of relays are different from each other. **(20) (CO 2) (PO 2)**

b) Define dead zone and protective zone in a typical power system with necessary figure. **(05) (CO 1) (PO 1)**

2 a) Suppose you want to provide 85% protection to the winding of a generator. Now, illustrate what protection scheme will you adopt to ensure 85% winding protection of the generator. Illustrate it with detail procedure. **(15) (CO 2) (PO 2)**

Now, its seen that 85% protection is not sufficient for your system. It is causing huge loss in the system as well as the generator winding is being damaged frequently. You want to implement 100% protection to your system. Illustrate how will you implement this 100% protection scheme in your generator.

b) An alternator winding protected by a percentage differential relay is shown in Figure 2(b). The relay has 0.25 A minimum pick up current and has a percentage slope of 10%. A high resistance ground fault has occurred near the grounded neutral end of the generator winding while generator is carrying load. Assume that the CT's have 400/5 amps ratio and no inaccuracies. Identify whether the relay will trip the generator CB under this fault condition or not. **(10) (CO 1) (PO 1)**

Figure 2(b)

3 a) Classify different types of busbar faults and illustrate frame leakage protection of busbar with necessary diagram. **(10) (CO 2) (PO 2)**

b) A typical power system is represented in Fig. 3(b)(i). Time grading margin between relay 1 and relay 2 is 0.6 sec for discrimination. If any fault occurs at point 'X' then calculate actual time of operation for both the relays and time setting multiplier for relay 2. Time setting multiplier of relay 1 is 0.3. A time-current characteristics curve is given in Fig. 3(b)(ii). (15) (CO 1) (PO 1)

Plug setting of relay 1: **100 %**

Plug setting of relay 2: **125 %**

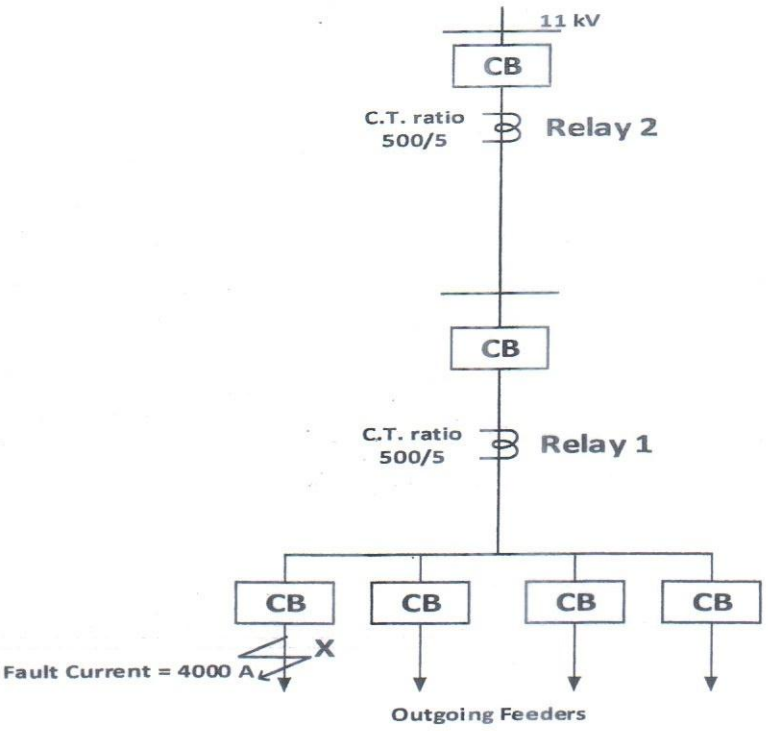


Figure 3(b)(i)

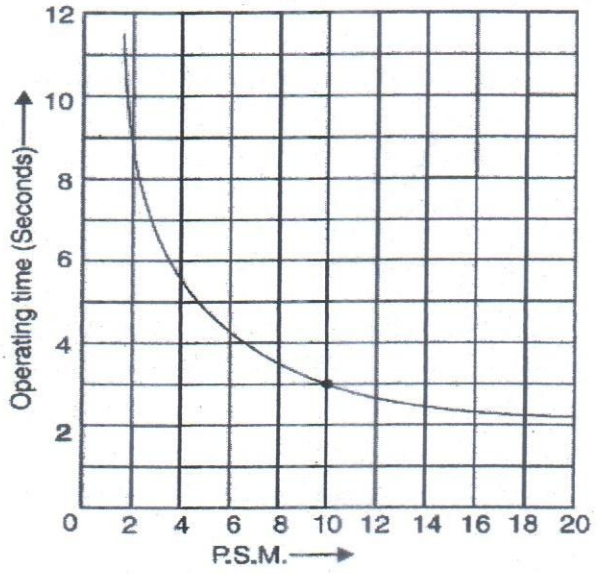


Fig. 3(b)(ii).

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Name of the Program: B.Sc. in EEE
Semester: 5th

Date: 29 September, 2022 (Morning)
Time: 10:30 am – 12:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4541
Course Title: Wireless Communication

Winter Semester, A. Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **3 (three)** questions. Answer all **3 (three)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

---

1. a) The following coax types are available. **8 (CO1, PO1)**

Coax Type	Diameter (mm)
RG4	5.74
RG5/U	8.4
RG9/U	10.7
RG10A/U	12.1
RG20A/U	30.4

There are four cases of signal transmission as shown below.

Case 1: Very high power transmission is required over narrow bandwidth
Case 2: Medium power transmission is required over narrow bandwidth
Case 3: Medium power transmission is required over medium bandwidth
Case 4: Low power transmission is required and the bandwidth requirement is not specified.

Select the right coax type for each of the four cases.

b) The current operating bandwidth is 10 MHz. The RF engineer wants to increase the data rate. He finds that the bandwidth can be increased to 11.5 MHz but this increase adds significant spurious emissions and the SNR drops from 10 dB to 8 dB. Determine whether the bandwidth should be increased or not. **12 (CO2, PO2)**

c) Determine whether modulation is performed for Ethernet, which creates a wired network by connecting computers through hubs or switches. **5 (CO1, PO1)**

2. a) Find an expression for received power in the case of two-ray model for a large distance between the transmitter and the receiver. **12 (CO1, PO1)**

b) A transmitter and a receiver are connected over a pure LOS link with no second ray between them. The transmit power and the antenna gain of the transmitter are 30 dBm and 15 dB, respectively. The electric field strength of the receiver at its position A is –12 dB. If the receiver is moved to position B, which is 1.5 km further away from the transmitter, then the electric field strength of the receiver becomes –18 dB. Assume that A, B, and the transmitter, are on the same straight line. Determine the distance between the transmitter and B. **13 (CO2, PO2)**

3. a) Figure 1 shows that wave A and wave B have 90^0 phase difference in space at time instant t. Wave A is traveling rightwards and wave B is traveling leftwards. Sketch the waveshapes for wave A and wave B and determine their phase difference in space at time instant t+t' where t'= T/6 and T represents a period. **8 (CO2, PO2)**

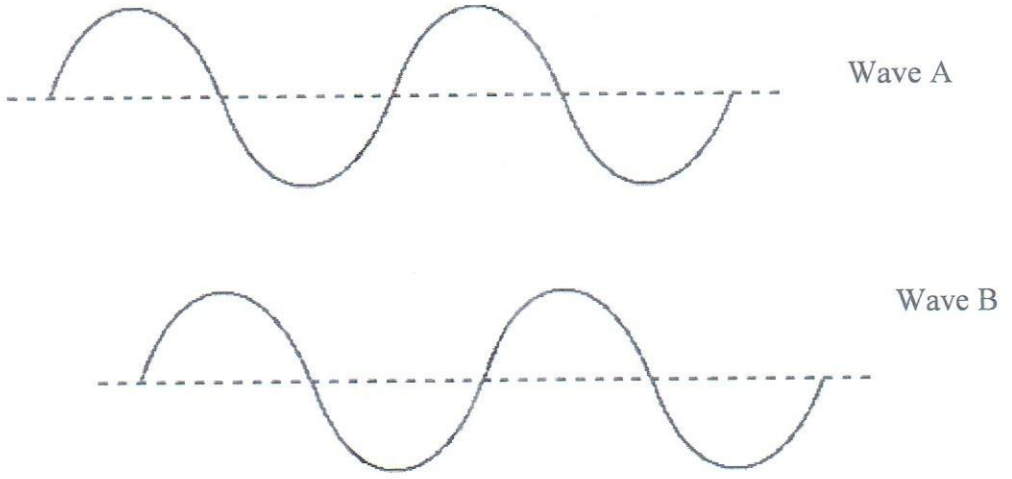

Figure 1

b) Discuss the possible frequency usage for 6G cellular communication. Define chrematistic impedance and chrematistic wave impedance. **5 (CO1, PO1)**

c) The power delay profile for a multipath environment is shown in Figure 2. The coherence time is 5 microseconds. Determine whether the multipath environment is underspread or overspread. **12 (CO2, PO2)**

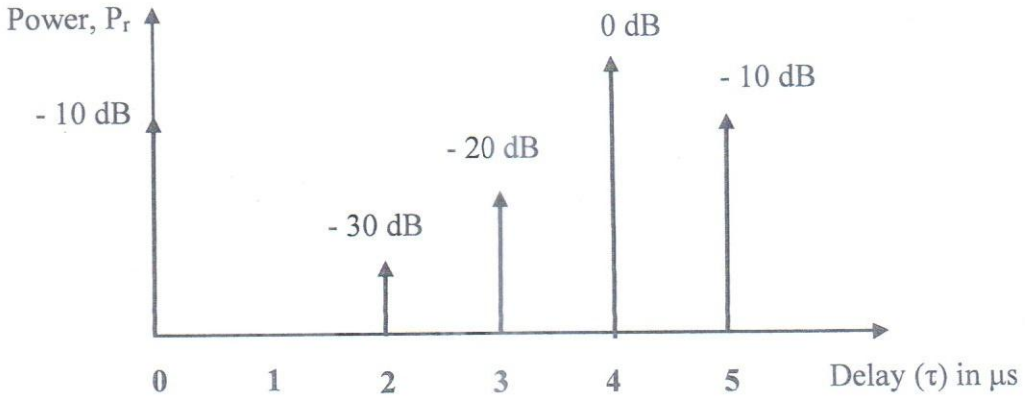

Figure 2

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Name of the Program: B.Sc. in EEE
Semester: 5th

Date: 04 October, 2022 (Morning)
Time: 10:30 am – 12:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No: EEE 4551
Course Title: Data Communication and Networking I

Winter Semester, A. Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **03 (three)** questions. Answer all **03 (three)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

---

1. a) Briefly explain the role of the electron as the primary medium for electronic data communication. Briefly discuss using suitable illustrations the low-level mechanisms and technologies used to send information across the physical communication medium. **10 (CO1, PO1)**

2. a) "Network has made telecommuting available to individuals" explain the statement with suitable examples and illustrations. **7 (CO1, PO1)**

b) Briefly discuss the categories of networks from the ownership point of view: i) Public Networks, and ii) Private Networks. **8 (CO1, PO1)**

3. *During the COVID-19 pandemic, IUT authority hires you as the network expert. Your task is to build a sustainable network solution among all the residential students staying at IUT so they can stay in their halls and access all the academic resources from their rooms.*

Student Statistics	
Hall	***Total number of Students***
South Hall	*600*
North Hall	*600*
Female Hall	*300*

Your job is to connect IUT halls of residents (i.e., South Hall, North Hall, and Female Hall), Academic Building 1, Academic Building 2, and IUT Library.

Depending on different service choices, the servers from Academic building 1, Academic Building 2, and IUT Library should be connected.

For better clarification, use suitable illustrations, diagrams, tables, and flowcharts as much as possible to answer the following questions depending on your design choice.

(95)

a) Considering the total number of users and services, explain your choice of the category of *Area Network (AN)* (e.g., WAN, LAN, MAN, CAN, PAN) where your network does belong. Briefly justify your answer with suitable illustrations and choice of Ethernet technology. **15 (CO2, CO3, PO2)**

Explain the kind of topology you prefer for your design, e.g., *ring, star, bus, mesh.* Justify your answer, considering the advantages and disadvantages of these topologies. For Internet connectivity, justify the suitable topology.

b) Briefly Justify your suitable choices of design- **15 (CO2, CO3, PO2)**

i) Communication media/wire connection, e.g., Twisted Pair, Coaxial Cable, Fiber Optic,
ii) Internet backbone and Internet Service Provider (ISP),
iii) Modems and Broadband Connectivity,
iv) TDM or FDM,
v) Packet switch or Circuit switch,
vi) Routers, Switches, Hubs.

c) While designing your network for specific services and demand from the above number of users, consider the followings- **20 (CO2, CO3, PO2)**

i) Explain the kind of *Servers* you prefer for each of the following network applications (software): *Email, File Transfer, Web browsing, Voice telephone calls (VoIP), Distributed databases, Audio/video teleconferencing, and Social networking.*

ii) Discuss four sources of *packet delays* for your network design with suitable illustrations. Explain the need for *queuing buffer* in packet switching. How does the queue create data loss in the network?

iii) Discuss the importance of managing the proper *Routing* of packets in your design. How does the *routing table* work in your network?

iv) Explain how you can design the *Throughput* for your network. Discuss the importance of Throughput for data transfer in your design. Clarify how *Bottleneck* can be occur if Throughput is not considered perfectly.

(96)

B.Sc. Engg. EEE 5th Semester — 29 September 2022 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION — **WINTER SEMESTER, 2021-2022**

DURATION: 1 HOUR 30 MINUTES — **FULL MARKS: 75**

CSE 4575: Data Structure and Algorithms

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 3 (three)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

---

1. a) Differentiate between the two concepts – *Pointer to an Array* and *Array of Pointers*, with appropriate code segment. — 8 (CO1) (PO1)

   b) Given a two-dimensional array of size n x n, write a program that checks whether the given square matrix is *symmetric* or not. A square matrix A is symmetric if $a_{ij} = a_{ji}$, for all i and j or $1 \leq i \leq n$, and $1 \leq j \leq n$. — 12 (CO1) (PO1)
   Here, n is any natural number. a_{ij} is an element at position (i, j) which is i^{th} row and j^{th} column in matrix A and a_{ji} is an element at position (j, i) which is j^{th} row and i^{th} column in matrix A.
   While writing the code, you must access the array elements using the concept of 'Pointers'.

   c) With a brief explanation, determine the output of the following program. — 5 (CO1) (PO1)

```
#include <iostream>
using namespace std;
int main()
{
    int num[5];
    int* p;
    p = num;
    *p = 10;
    *(++p) = 20;
    p = &num[2];
    *p = 30;
    *(++p) = (*p)++;
    p = num;
    *(p + 4) = 50;
    for (int i = 0; i < 5; i++)
        cout << num[i] << ", ";
    return 0;
}
```

Figure-1: Code snippet for Question 1.(c).

2. a) Explain the role of the 'tail' pointer in case of a Singly Linked List. Does the presence of the 'tail' pointer improve runtime complexity of any operations on Singly Linked List? Justify your answer in either case. — 8 (CO1) (PO1)

   b) Given a Singly Linked List of Integers with only 'head' pointer, write a program to reverse the given linked list. An example is given below. — 12 (CO1) (PO1)

Input:
Head → 1 → 2 → 3
Output:
Head → 3 → 2 → 1

Assume that the linked list may have *n* number of nodes. While writing the code, use the following class definitions given in Figure-2.

```
Class Node{
public:
    int key;
    Node* next;
};
```

```
class LinkedList{
public:
    Node* head;
};
```

Figure 2: Class definition for Question 2. (b).

c) With brief justification, fill in the blanks in the following table (table 1) by putting appropriate values of runtime complexity (in Big-O notation) for different operations. 5 (CO1) (PO1)

Table 1: Runtime Complexity

Operation type	using Array	using Singly Linked List (without tail pointer)	using Doubly Linked List (with tail pointer)
accessing any elements arbitrarily			
deleting an element from the end of a list			

3. a) Apply algorithmic method to change the following expression in postfix notation using a Stack. Show each step of the conversion including stack contents and postfix expression using a simulation table. 8 (CO2) (PO2)

$$A * B - F / G + H / I * C - D * E$$

b) The 0/1 Knapsack Problem is a very famous problem in Computer Science. The problem statement is given below: 10 (CO2) (PO2)
Given a set of items, each of which is associated with some weight and value. Find the subset of items which can be carried in a knapsack of capacity W (where W is the weight). It is required that the cumulative value of the items in the knapsack is maximum value possible.
In simple words, it asks you to pick certain items from the set of items such that their total weight is less than or equal to *W* and the sum of their values is maximum. The given variables are weight array containing weight of each item, value array containing value of each item, *W* representing the capacity of the knapsack and *N* specifying a particular item.

Formulate a recursive solution of the 0/1 knapsack problem. Your job is to write the recursive formula with appropriate justification.

c) Write a recursive function *Knapsack* that takes the four parameters – weight, value, *W, N,* as mentioned in Question 3(b). The function must return the maximum value possible. 7 (CO2) (PO2)

Name of the Program: B. Sc. in EEE
Semester: 7th semester

Date: 30 September, 2022
Time: 2:30 pm – 4:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course Number: EEE 4703
Course Title: Communication Engineering II

Winter Semester: 2021 - 2022
Full Marks: 75
Time: 90 Minutes

There are **3 (three)** questions. Answer **all 3 (three)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

---

1. a) Given the spectrum — 10

$$G_x(f) = 10^{-4}\left\{\frac{\sin[\pi(f-10^6)10^{-4}]}{\pi(f-10^6)10^{-4}}\right\}^2$$

Find the value of the signal bandwidth using the following bandwidth definitions:

(i) Half-power bandwidth,
(ii) Noise equivalent bandwidth,
(iii) Null-to-null bandwidth,
(iv) 99% of power bandwidth,
(v) Absolute bandwidth.

b) Formulate the condition for maximizing SNR of a digital communication receiver system. — 10 — CO1, PO1

c) Classify the following signals as energy signals or power signals. Find the normalized energy or normalized power of each — 5

(i) $x(t) = \cos t + 5\cos\ 2t$ for $-\infty < t < \infty$

(ii) $x(t) = \begin{cases} A\exp(-at) & \text{for } t > 0, a > 0 \\ 0 & \text{elsewhere} \end{cases}$

2. a) Derive the transfer function of Duobinary Signaling. — 10

b) Derive the probability of error performance of binary (bipolar) signaling. — 10

c) In a WiFi digital audio transmission, an analog signal is digitized so that the ratio of the peak-signal to the peak-quantization noise power is at least 96 dB. The sampling rate is 44.1 kilosamples/s — 5 — CO1, PO1

(i) Determine the number of quantization levels of the analog signal are needed for $(S/N)_{peak} = 96$ dB.
(ii) Determine the number of bits per sample are needed for the number of levels found.
(iii) Evaluate the data rate in bits/s.

3. a) Evaluate Energy Spectral Density (ESD) and Power Spectral Density (PSD) of a periodic signal. 10

b) Explain PSD and autocorrelation of a random process. 10

c) In digital communications, both message and noise are modeled as WSS random processes. Consider a message $\mathbf{m}(t)$, whose autocorrelation function is $\mathbf{R}m(\tau)=Ae^{-|\tau|}$ (watts). The message $\mathbf{m}(t)$ is corrupted by zero-mean additive white Gaussian noise (AWGN) $\mathbf{n}(t)$ of spectral strength $N_0/2$ (watts/hertz) and the received signal is $\mathbf{r}(t) = \mathbf{m}(t) + \mathbf{n}(t)$. You decide to filter the noise by passing $\mathbf{r}(t)$ through an ideal lowpass filter with bandwidth W. The procedure is depicted in block diagram form in Figure 2(c). 5

CO1, PO1

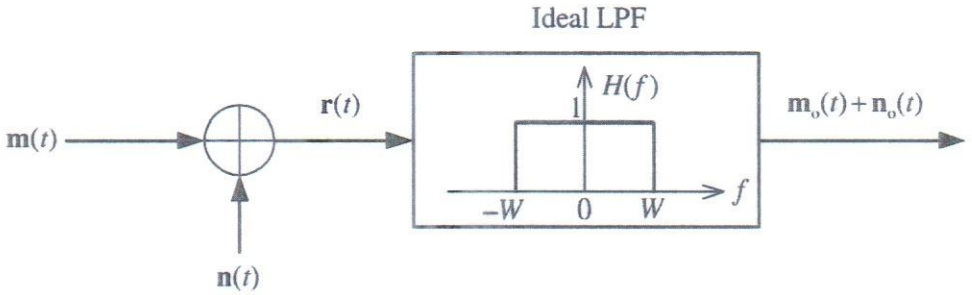

Figure 2(c)

(i) Show that the PSD of the message is given by:

$$S\mathbf{m}(f) = 2A/(1 + 4\pi^2 f^2), \quad \text{where } -\infty \leq f \leq \infty$$

(ii) Determine the power of the noise at the output of the filter.

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Name of the Program: B.Sc. Engg. (EE)
Semester: 7th Sem.

Date: 3rd October, 2022
Time: 2:30 pm – 4:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination — **Winter Semester : 2021 - 2022**
Course Number: EEE 4705 — **Full Marks: 75**
Course Title: Microcontroller Based System Design — **Time : 90 minutes**

There are **4 (four)** questions. Answer any **3 (three)**. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. Assume any reasonable value for missing data (if any).

1.a) Design a square wave generator of 33% duty cycle on any pin of P1 of AT89C51 using assembly language. The time period should be 15 *ms*. Use a crystal frequency of 22 *MHz*. [Show necessary calculations]. **(18) (CO2) (PO3)**

b) Describe the criteria for choosing a microcontroller. **(07) (CO1) (PO1)**

2.a) Design a palindrome checker of 56 bits using assembly language. Assume a string of length 56 bits is saved in RAM locations 30H onwards. If it's a palindrome send "Y" to P1 of AT89C51. [A palindrome is a string in which the characters are same whether the string is read in the forward or backward direction, e.g. 'civic']. **(18) (CO2) (PO3)**

b) Describe the different addressing modes in AT89C51 with proper examples. **(07) (CO1) (PO1)**

3.a) Design a multi-byte (16-bit) subtractor and make necessary modifications within the code for negative results using assembly language. (The sign of the result should be interpreted from the carry flag and the actual result should be stored in memory locations). [Show necessary calculations]. **(18) (CO2) (PO3)**

b) Interpret stack and bank 1 conflict. **(07) (CO1) (PO1)**

(10)

4.a)	Design a security system to prevent overheating of a vehicle using assembly language. Continuously monitor the temperature of the vehicle (assume the binary data is available) through one of the ports of AT89C51. If the temperature exceeds 210 ^0F, simultaneously turn on a buzzer and illuminate a red light. [Show necessary calculations].	**(18)**	**(CO2)** **(PO3)**
b)	Explain the different fields in the structure of assembly language with proper examples.	**(07)**	**(CO1)** **(PO1)**

8051 Instruction Set Summary

Rn Register R7-R0 of the currently selected Register Bank.
Data 8-bit internal data location's address. This could be an internal Data RAM location (0-127) or a SFR [i.e. I/O port, control register, status register, etc. (128-255)].
@Ri 8-bit Internal Data RAM location (0-255) addressed indirectly through register R1 or R0.
#data 8-bit constant included in instruction.
#data16 16-bit constant included in instruction.
addr16 16-bit destination address. Used by LCALL and LJMP. A branch can be anywhere within the 64k byte Program Memory address space.
addr11 11-bit destination address. Used by ACALL and AJMP. The branch will be within the same 2k byte page of Program Memory as the first byte of the following instruction.
rel Signed (two's component) 8-bit offset byte. Used by SJMP and all conditional jumps. Range is –128 to +127 bytes relative to first byte of the following instruction.
bit Direct Addressed bit in Internal Data RAM or Special Function Register.

Instruction	Flag			Instruction	Flag		
	C	OV	AC		C	OV	AC
ADD	X	X	X	CLR C	0		
ADDC	X	X	X	CPL C	X		
SUBB	X	X	X	ANL C,bit	X		
MUL	0	X		ANL C,/bit	X		
DIV	0	X		ORL C,bit	X		
DA	X			ORL C,/bit	X		
RRC	X			MOV C,bit	X		
RLC	X			CJNE	X		
SETB C	1						

Note that operations on SFR byte address 206 or bit addresses 209-215 (i.e. the PSW or bits in the PSW) will also affect flag settings.

Mnemonic		Description	Byte	Cycle
Arithmetic operations				
ADD	A,Rn	Add register to accumulator	1	1
ADD	A,direct	Add direct byte to accumulator	2	1
ADD	A,@Ri	Add indirect RAM to accumulator	1	1
ADD	A,#data	Add immediate data to accumulator	2	1
ADDC	A,Rn	Add register to accumulator with carry flag	1	1
ADDC	A,direct	Add direct byte to A with carry flag	2	1
ADDC	A,@Ri	Add indirect RAM to A with carry flag	1	1
ADDC	A,#data	Add immediate data to A with carry flag	2	1
SUBB	A,Rn	Subtract register to accumulator with borrow	1	1
SUBB	A,direct	Subtract direct byte to A with carry borrow	2	1
SUBB	A,@Ri	Subtract indirect RAM to A with carry borrow	1	1
SUBB	A,#data	Subtract immediate data to A with carry borrow	2	1
INC	A	Increment accumulator	1	1
INC	Rn	Increment register	1	1
INC	direct	Increment direct byte	2	1
INC	@Ri	Increment indirect RAM	1	1
DEC	A	Decrement accumulator	1	1
DEC	Rn	Decrement register	1	1
DEC	direct	Decrement direct byte	2	1
DEC	@Ri	Decrement indirect RAM	1	1
INC	DPTR	Increment data pointer	1	2
MUL	AB	Multiply A and B -> [B hi]:[A lo]	1	4
DIV	AB	Divide A by B -> A=result, B=remainder	1	4
DA	A	Decimal adjust accumulator	1	1
CLR	A	Clear accumulator	1	1
CPL	A	Complement accumulator	1	1
RL	A	Rotate accumulator left	1	1
RLC	A	Rotate accumulator left through carry	1	1
RR	A	Rotate accumulator right	1	1
RRC	A	Rotate accumulator right through carry	1	1
SWAP	A	Swap nibbles within the accumulator	1	1
Logic operations				
ANL	A,Rn	AND register to accumulator	1	1
ANL	A,direct	AND direct byte to accumulator	2	1
ANL	A,@Ri	AND indirect RAM to accumulator	1	1
ANL	A,#data	AND immediate data to accumulator	2	1
ANL	direct,A	AND accumulator to direct byte	2	1
ANL	direct,#data	AND immediate data to direct byte	3	2
ORL	A,Rn	OR register to accumulator	1	1
ORL	A,direct	OR direct byte to accumulator	2	1
ORL	A,@Ri	OR indirect RAM to accumulator	1	1
ORL	A,#data	OR immediate data to accumulator	2	1
ORL	direct,A	OR accumulator to direct byte	2	1
ORL	direct,#data	OR immediate data to direct byte	3	2
XRL	A,Rn	Exclusive OR register to accumulator	1	1
XRL	A,direct	Exclusive OR direct byte to accumulator	2	1
XRL	A,@Ri	Exclusive OR indirect RAM to accumulator	1	1
XRL	A,#data	Exclusive OR immediate data to accumulator	2	1
XRL	direct,A	Exclusive OR accumulator to direct byte	2	1
XRL	direct,#data	Exclusive OR immediate data to direct byte	3	2
Boolean variable manipulation				
CLR	C	Clear carry flag	1	1
CLR	bit	Clear direct bit	2	1
SETB	C	Set carry flag	1	1
SETB	bit	Set direct bit	2	1
CPL	C	Complement carry flag	1	1
CPL	bit	Complement direct bit	2	1
ANL	C,bit	AND direct bit to carry flag	2	2
ANL	C,/bit	AND complement of direct bit to carry	2	2
ORL	C,bit	OR direct bit to carry flag	2	2
ORL	C,/bit	OR complement of direct bit to carry	2	2
MOV	C,bit	Move direct bit to carry flag	2	1
MOV	bit,C	Move carry flag to direct bit	2	2
Program and machine control				
ACALL	addr11	Absolute subroutine call	2	2
LCALL	addr16	Long subroutine call	3	2
RET		Return from subroutine	1	2
RETI		Return from interrupt	1	2
AJMP	addr11	Absolute jump	2	2
LJMP	addr16	Long jump	3	2
SJMP	rel	Short jump (relative address)	2	2
JMP	@A+DPTR	Jump indirect relative to the DPTR	1	2
JZ	rel	Jump if accumulator is zero	2	2
JNZ	rel	Jump if accumulator is not zero	2	2
JC	rel	Jump if carry flag is set	2	2
JNC	rel	Jump if carry flag is not set	2	2
JB	bit,rel	Jump if bit is set	3	2
JNB	bit,rel	Jump if bit is not set	3	2
JBC	bit,rel	Jump if direct bit is set and clear bit	3	2
CJNE	A,direct,rel	Compare direct byte to A and jump if not equal	3	2
CJNE	A,#data,rel	Compare immediate to A and jump if not equal	3	2
CJNE	Rn,#data,rel	Compare immed. to reg. and jump if not equal	3	2
CJNE	@Rn,#data,rel	Compare immed. to ind. and jump if not equal	3	2
DJNZ	Rn,rel	Decrement register and jump in not zero	2	2
DJNZ	direct,rel	Decrement direct byte and jump in not zero	3	2
NOP		No operation	1	1
Data transfer				
MOV	A,Rn	Move register to accumulator	1	1
MOV	A,direct*)	Move direct byte to accumulator	2	1
MOV	A,@Ri	Move indirect RAM to accumulator	1	1
MOV	A,#data	Move immediate data to accumulator	2	1
MOV	Rn,A	Move accumulator to register	1	1
MOV	Rn,direct	Move direct byte to register	2	2
MOV	Rn,#data	Move immediate data to register	2	1
MOV	direct,A	Move accumulator to direct byte	2	1
MOV	direct,Rn	Move register to direct byte	2	2
MOV	direct,direct	Move direct byte to direct byte	3	2
MOV	direct,@Ri	Move indirect RAM to direct byte	2	2
MOV	direct,#data	Move immediate data to direct byte	3	2
MOV	@Ri,A	Move accumulator to indirect RAM	1	1
MOV	@Ri,direct	Move direct byte to indirect RAM	2	2
MOV	@Ri,#data	Move immediate data to indirect RAM	2	1
MOV	DPTR,#data16	Load data pointer with a 16-bit constant	3	2
MOVC	A,@A+DPTR	Move code byte relative to DPTR to accumulator	1	2
MOVC	A,@A+PC	Move code byte relative to PC to accumulator	1	2
MOVX	A,@Ri	Move external RAM (8-bit addr.) to A	1	2
MOVX	A,@DPTR	Move external RAM (16-bit addr.) to A	1	2
MOVX	@Ri,A	Move A to external RAM (8-bit addr.)	1	2
MOVX	@DPTR,A	Move A to external RAM (16-bit addr.)	1	2
PUSH	direct	Push direct byte onto stack	2	2
POP	direct	Pop direct byte from stack	2	2
XCH	A,Rn	Exchange register to accumulator	1	1
XCH	A,direct	Exchange direct byte to accumulator	2	1
XCH	A,@Ri	Exchange indirect RAM to accumulator	1	1
XCHD	A,@Ri	Exchange low-order nibble indir. RAM with A	1	1

*) MOV A,ACC is not a valid instruction

```
jne  A,#data,@                  cjne   A,#data,@
  (jump if A ! = data)

je   A, #data,@                 add    A,#low( data)    or      cjne   A,#(data),ne
  (jump if A == data)           jz     @                        jmp    @
                                                        ne:     ...

ja, jnbe  A,#data,@             add    A,#low( data 1)  or      cjne   A,#(data+1),ne
  (jump if A > data)            jc     @                ne:     jnc    @

jae, jnb  A,#data,@             add    A,#low( data)    or      cjne   A,#(data),ne
  (jump if A >= data)           jc     @                ne:     jnc    @

jb, jnae  A,#data,@             add    A,#low,( data)   or      cjne   A,#(data),ne
  (jump if A < data)            jnc    @                ne:     jc     @

jbe, jna  A,#data,@             add    A,#low( data 1)  or      cjne   A,#(data+1),ne
  (jump if A <= data)           jnc    @                ne:     jc     @

switch  A <,==,> #data          cjne   A,#data,ne
  (no A modification)           ...                             ; execute code if A==data
                          ne:   jc     is_below                 ; jump if A<data
                                jnc    is_above                 ; jump if A>data or exec. code
```

BSc.Eng/7th Sem. (EEE) 29 September 2022 (Thursday 2:30 pm)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid-Semester Examination — Winter Semester, A.Y. 2021-2022
Course No. Hum 4721 — Time : 1½ hours
Course Title: Engineering Economy — Full Marks : 50

There are **3** (Three) Questions. Answers all of them. Make impression for margins in the answer booklet, not lines. Write Q No. on the top of the sheet above the impression and a, b, c on the left of the impression.
Use the graph paper wherever necessary. Marks in the right margin indicate the full marks.

Q no.		Question	Marks CO/PO
1	a.	Describe engineering profession (its meaning, role/s of an engineer, engineering process). Use the keywords and key points but write adequately.	4 CO1/ PO1
	b.	State the function and purpose of engineering economics. Enlighten the role of engineering economics in decision making.	4 CO1/ PO2
	c.	Explain uncertainty. State some basic causes of uncertainty in engineering economy studies.	$3^2/_3$ CO1/ PO2
	d.	In every field of Engineering education, lecturers teach their students the concept SYSTEM for the benefit of mankind. "Islam is the all-embracing knowledge-based System of life given by the Creator". Explain the statement relating to the scope of this knowledge for the overall-benefit of all creatures and ecosystems.	5 CO1/PO8
2	a.	A company is following the budgetary time line of the respective country, which is July to June of the consecutive calendar years. Its electrical appliances production data is given in Table below:	10 CO1/PO2

Data collection period (month)	Volume of production/activity ('000' units)	Total costs of production in Tk. (million)	Total fixed cost	Total variable cost	Remark
July 2021	29	39.6			
August	32	40.95			
September	38	47.7			
October	15	22.5			
November	45	63			
December	35	44.1			
January 2022	30	41.4			
February	22	27			
March	33	43.2			
April	39	49.5			
May	41	51.3			
June	24	27.9			
Total					

i. Draw the data in a graph paper (total cost vs volume, not total cost vs time period) and locate the high and low activity levels in terms of production volume and cost involved (months).
ii. Then, determine the variable cost per unit (v) and the total fixed cost (F).
iii. Express the results in an equation in the form $y = c + vx$, where y stands for the total cost or revenue, c stands for fixed costs, v stands for variable costs per unit and x stands for volume of activity (units).

Complete the table in your answer booklet.
iv. Verify the results (fixed costs and variable costs per unit) found from graphical solution and analytical solution.

b. The price and demand relationship of an electrical device is $Q = 1{,}500 - 24.6p$, and the profit function is $Z = R - F - vQ$, where symbols stand for their usual meanings. Now, if fixed cost F is constant and \$10,000 and variable cost per unit v = \$8. Determine:
i. Profit function in terms of price.
ii. Price for highest level of profit.
iii. Maximum total profit, and
iv. Optimal production volume.

$6^2/_3$ CO1/PO/2

3 a. Describe the main five features of future value of money. 3 CO2/PO1

b. Highlight the main similarities and differences between annual rate and effective annual rate (EAR) interest. 3 CO2/PO2

c. A company producing 12-year electrical metering devices has the following cash flow information. When the proposal was mooted one year back, a consultancy cost took one million Taka. At year zero, the building construction costs, equipment costs, land price, and working capital were amounted Tk6, Tk3, Tk2.5 and Tk1 million respectively. The return in the year 12 is equipment sale Tk4 million, building sale Tk3.5 and land value Tk5 million. After all operations and maintenance costs, Tk750,000 per year, the expected annual return is Tk2.75 million. Use MARR 10%. Determine the present value, future worth, and the average annual return. Draw the relevant cash flow diagrams. Suppose, plant manager asked you to find the arithmetic gradient amount at 10% discounted rate, determine the gradient amount. $9^2/_3$ CO2/PO1 1

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Name of the Program: B.Sc. in EEE
Semester: 7th

Date: 5th October, 2023
Time: 2:30 pm – 4:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4763
Course Title: Medical Electronics

Winter Semester, A. Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **3 (three)** questions. Answer all **3 (three)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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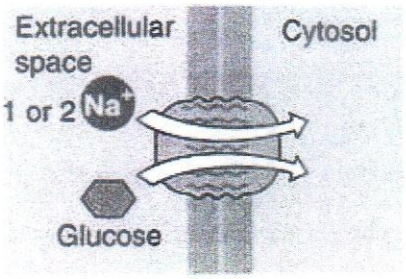
1. a) Describe the basis of action potential. Explain the process of neural communication. **15 (CO1, PO1)**

   b) For the Na-Glucose co-transporter (figure below), calculate the number of Na ions required to maintain the spontaneity of the transportation. Only one glucose molecule is transported during each cycle. **10 (CO2, PO2)**
   T = 37°C, Faraday's constant = 96469 C/mol, Membrane potential, Ψ_{in} = -80mv, Ψ_{out} = 0. $\Delta\mu_{tot} = \Delta\mu_{Na} + \Delta\mu_{glu.}$

Transported particles	Extracellular	Intracellular
Glucose	100 mg/dl	10,000 mg/dl
Na	145 mM	14 mM



2. a) Describe the Cardiac cycle with a figure showing the changes in ventricles. **10 (CO1, PO1)**

   b) State the thermocouple laws. **6 (CO1, PO1)**

   c) Explain the process of measuring pH using pH electrode. **9 (CO1, PO1)**

3. a) Explain the idea of Wilson central terminal. **10 (CO1, PO1)**

   b) Construct an inverting amplifier with an input resistance of 20kΩ and a gain of 10. **8 (CO1, PO1)**

   c) Draw a constant temperature circuit and describe its working principle. **7 (CO1, PO1)**

M.Sc. Engg./ PhD (EE) Date: October 05, 2022 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 6307
Course Title: Power System Modeling

Winter Semester, A.Y.2021-2022
Time: 90 Minutes
Full Marks: 75

There are **4 (four)** questions. Answer **any 3 (three)** questions. All questions carry equal marks. Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. All symbols carry their usual meanings.

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1. a) Fig. 1(a) represents the cross-sectional view of a two-pole synchronous machine with damper coils. 20

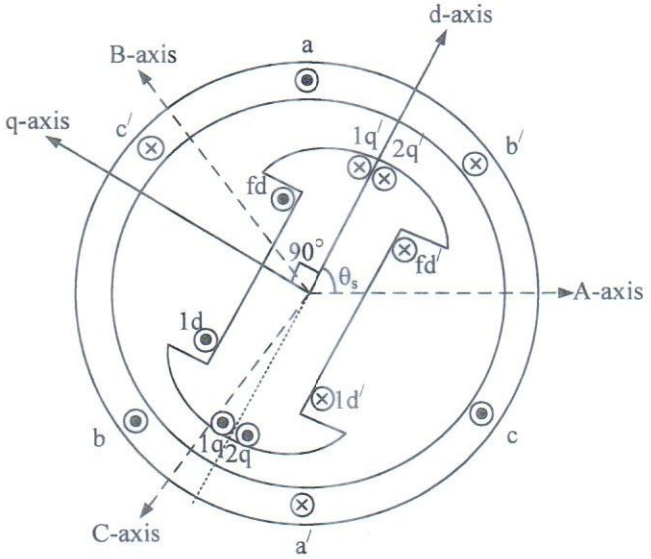

Fig. 1(a)

i) Mention the benefit of measuring the rotor angular position with respect to a synchronously rotating reference frame.
ii) Explain the reasons for including damper coils in the model.
iii) Find the expression of inductance l_{bb}.

b) Redraw the diagram of Fig. 1(a) for representing the synchronous machine *Model 1.2*. Obtain the stator circuit and rotor circuit voltage expressions for that model. 05

2. a) Mention the advantages of introducing Park's transformation in developing the synchronous machine dynamic model. 05

b) Consider a given abc-dq0 transformation matrix T_{dq0} as follows. 12

$$T_{dq0} = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos(\theta_s) & \cos(\theta_s - 120^\circ) & \cos(\theta_s + 120^\circ) \\ -\sin(\theta_s) & -\sin(\theta_s - 120^\circ) & -\sin(\theta_s + 120^\circ) \\ \sqrt{\frac{1}{2}} & \sqrt{\frac{1}{2}} & \sqrt{\frac{1}{2}} \end{bmatrix}$$

A balanced set of currents in the *a-b-c* frame is given as

$$\begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} = \begin{bmatrix} I_m \sin(\omega_s t) \\ I_m \sin(\omega_s t - 120^\circ) \\ I_m \sin(\omega_s t + 120^\circ) \end{bmatrix}$$

Find out the corresponding expression of currents in the *d-q-0* reference frame.

c) The per unit reactances and resistances of the *d-q* frame voltage-current circuits of a synchronous machine on its own base are given as 08

$X_d = 1.8$, $X_{md} = 1.62$, $X_{ffd} = 0.11$, $X_{l1d} = 0.09$, $X_{mq} = 1.51$, $X_{l1q} = 0.44$, $X_{l2q} = 0.07$

Determine the values of transient and sub-transient reactances.

3. a) A synchronous machine is supplying a local load requiring real power, $P_e = e_d I_d + e_q I_q$. Assuming the one-axis machine model with negligible stator resistance, express the power in terms of state variables. 05

b) Consider a synchronous generator supplying real power, $P_e = 1.0$ per unit and reactive power, $Q_e = 0.15$ per unit to a local load with terminal voltage $E_t = 1.0$ per unit. The machine parameters (in per unit) are given as follows: 20

$X_l = 0.1$, $X_d = 1.2$, $X_q = 1.0$, $X_d' = 0.7$, $X_q' = 0.75$, $X_d'' = 0.3$, $X_q'' = 0.3$.

Considering negligible stator resistance, calculate the steady state values of all state variables for the sub-transient synchronous generator model.

4. a) The dynamic model of a single machine infinite bus system is expressed as: 20

$$\dot{\delta} = \omega_{base}(\omega - 1)$$

$$\dot{\omega} = \frac{1}{2H}(P_m - P_e - P_D)$$

$$\dot{E}_q' = \frac{1}{T_{d0}'}(E_{fd} - E_q)$$

where,

$$P_e = e_d I_d + e_q I_q; \quad P_D = D(\omega - 1); \; E_q = E_q' + (X_d - X_d')I_d;$$

$$e_d = X_q I_q; \; e_q = E_q' - X_d' I_d; \; I_d = \frac{E_q' - V_b \cos\delta_0}{X_d' + X_L}; \; I_q = \frac{V_b \sin\delta_0}{X_q + X_L}.$$

Obtain the corresponding linearized state space representation of the form,

$$\Delta\dot{X} = A\Delta X + B\Delta U.$$

b) What is the essence of studying synchronous machine models having different order of complexity? How does the model order affect the accuracy and simulation time? 05

EEE 6307: Formula sheet

Park's Transformation:

$$T_{dq0} = k_1 \begin{bmatrix} \cos\theta_s & \cos(\theta_s - 120^\circ) & \cos(\theta_s + 120^\circ) \\ -\sin\theta_s & -\sin(\theta_s - 120^\circ) & -\sin(\theta_s + 120^\circ) \\ k_2 & k_2 & k_2 \end{bmatrix}$$

Inductance Definitions:

$$l_{md} = l_d - l_{ls}$$

$$l_{mq} = l_q - l_{ls}$$

Inverse Park's Transformation:

$$T_{dq0}^{-1} = \begin{bmatrix} \cos\theta_s & -\sin\theta_s & 1 \\ \cos(\theta_s - 120^\circ) & -\sin(\theta_s - 120^\circ) & 1 \\ \cos(\theta_s + 120^\circ) & -\sin(\theta_s + 120^\circ) & 1 \end{bmatrix}$$

d-axis flux linkage:

$$\begin{bmatrix} \psi_d \\ \psi_{fd} \\ \psi_{1d} \end{bmatrix} = \begin{bmatrix} X_d & X_{md} & X_{md} \\ X_{md} & X_{fd} & X_{md} \\ X_{md} & X_{md} & X_{1d} \end{bmatrix} \begin{bmatrix} -I_d \\ I_{fd} \\ I_{1d} \end{bmatrix}$$

q-axis flux linkage:

$$\begin{bmatrix} \psi_q \\ \psi_{1q} \\ \psi_{2q} \end{bmatrix} = \begin{bmatrix} X_q & X_{mq} & X_{mq} \\ X_{mq} & X_{1q} & X_{mq} \\ X_{mq} & X_{mq} & X_{2q} \end{bmatrix} \begin{bmatrix} -I_q \\ I_{1q} \\ I_{2q} \end{bmatrix}$$

The sub-transient Model:

$$T_{d0}'' \frac{d\psi_{1d}}{dt} = E_q' - \psi_{1d} - (X_d' - X_l) I_d$$

$$T_{q0}'' \frac{d\psi_{2q}}{dt} = -E_d' - \psi_{2q} - (X_q' - X_l) I_q$$

$$T_{d0}' \frac{dE_q'}{dt} = E_{fd} - \frac{(X_d' - X_d'')(X_d - X_d')}{(X_d' - X_l)^2} \left(E_q' - \psi_{1d} + \frac{(X_d' - X_l)(X_d'' - X_l)}{(X_d' - X_d'')} I_d \right) - E_q'$$

$$T_{q0}' \frac{dE_d'}{dt} = e_{1q} - \frac{(X_q' - X_q'')(X_q - X_q')}{(X_q' - X_l)^2} \left(-E_d' - \psi_{2q} + \frac{(X_q' - X_l)(X_q'' - X_l)}{(X_q' - X_q'')} I_q \right) + E_d'$$

$$\frac{d\delta}{dt} = \omega_{base}(\omega - 1)$$

$$2H \frac{d\omega}{dt} = P_m - P_e - D(\omega - 1)$$

$$E_d'' - e_d = R_s I_d - X_q'' I_q$$

$$E_q'' - e_q = R_s I_q + X_d'' I_d$$

The transient Model (Two-axis):	The transient Model (One-axis):
$T'_{d0}\frac{dE'_q}{dt} = E_{fd} - (X_d - X'_d)I_d - E'_q$ $T'_{q0}\frac{dE'_d}{dt} = -(X_q - X'_q)I_q + E'_d$ $\frac{d\delta}{dt} = \omega_{base}(\omega - 1)$ $2H\frac{d\omega}{dt} = P_m - P_e - D(\omega - 1)$ $E'_d = e_d + R_s I_d - X'_q I_q$ $E'_q = e_q + R_s I_q + X'_d I_d$	$T'_{d0}\frac{dE'_q}{dt} = E_{fd} - (X_d - X'_d)I_d - E'_q$ $\frac{d\delta}{dt} = \omega_{base}(\omega - 1)$ $2H\frac{d\omega}{dt} = P_m - P_e - D(\omega - 1)$ $e_d = X_q I_q - R_s I_d$ $e_q = E'_q - R_s I_q - X'_d I_d$

M.Sc. Engg./ Ph.D (EE)
(Afternoon)

Date: 28 September, 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid Semester Examination
Course No.: EEE 6401
Course Title: Optical Communication

Winter Semester, A. Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **4 (four)** questions. Answer **any 3 (three)** questions. All questions carry equal marks. Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper.

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1. a) Explain modes theory for circular waveguides. 10

   b) A step index fiber has NA of 0.16, core RI of 1.45, sore diameter of 60 μm. Determine the normalized frequency for the fiber when light at a wavelength of 0.82 μm is transmitted. Estimate the number of guided modes. 5

   c) Derive normalized frequency, V of optical fiber and show that for graded index fiber number of modes, $M = V^2/4$. 10

2. a) Discuss the operating principle of a p-i-n and avalanche photodiode. 10

   b) Derive the SNR for shot noise dominated optical receiver. Explain the concept of population inversion. 10

   c) Find the composition of the quaternary alloy InGaAsP for making semiconductor lasers operating at 1.3 μm and 1.55 μm wavelengths. 5

3. a) Draw the energy band diagram for heterostructure p-n junction and state its benefit over homostructure. 10

   b) What are the advantages of p-n photodiode over p-i-n photodiode? Show that the responsivity of a photodiode increases with the wavelength. 10

   c) Draw the loss curve of an optical fiber for various wavelengths and explain the reasons of various peaks occurred. 5

4. Discuss the following: 25
   i) Photonic Crystal Fiber (PCF),
   ii) Single-mode and multi-mode fiber,
   iii) Direct and indirect bandgap material,
   iv) Heterostructure p-n junction..

Name of the Program: M.Sc. Engg./Ph.D.

Date: September 30, 2022
Time: 2:30 pm – 4:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course Number: EEE 6413
Course Title: Engineering Optimization

Winter Semester: 2021 - 2022
Full Marks: 75
Time: 1 Hour 30 Minutes

There are **04 (four)** questions. Answer any **03 (three)** questions. The symbols have their usual meanings. Marks of each question are written in the brackets in right margin.

1.a) Explain why optimization is necessary especially in engineering? **(03)**

b) State a constrained and an unconstrained optimization problem. Briefly explain Design Vector, Design Constraints, Constraint Surface, Objective Function, Objective Function Surfaces with necessary equation and suitable diagram as per necessity. **(10)**

c) A rocket is designed to travel a distance of 12 s in a vertically upward direction [1.39]. The thrust of the rocket can be changed only at the discrete points located at distances of 0, s, 2s, 3s, . . . , 12s. If the maximum thrust that can be developed at point i either in the positive or negative direction is restricted to a value of Fi, formulate the problem of minimizing the total time of travel under the following assumptions: **(12)**

i. The rocket travels against the gravitational force.
ii. The mass of the rocket reduces in proportion to the distance traveled.
iii. The air resistance is proportional to the velocity of the rocket.

2.a) With suitable diagram, illustrate different types of extreme point **(05)**

b) By using a graphical method, solve the optimization problem **(12)**

$$\text{minimize } f(\mathbf{x}) = x_1^2 + x_2^2 + 2x_2$$
$$\text{subject to: } a_1(\mathbf{x}) = x_1^2 + x_2^2 - 1 = 0$$
$$c_1(\mathbf{x}) = x_1 + x_2 - 0.5 \geq 0$$
$$c_2(\mathbf{x}) = x_1 \geq 0$$
$$c_3(\mathbf{x}) = x_2 \geq 0$$

c) Point $x* = [\ 1/2\ 0]^T$ is a local minimizer of the problem **(8)**

$$\text{minimize } f(x_1, x_2) = x_1^2 - x_1 + x_2 + x_1 x_2$$
$$\text{subject to : } x_1 \geq 0,\ x_2 \geq 0$$

Show that the necessary conditions for $x*$ to be a local minimizer are satisfied using suitable feasible direction.

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3.a) Define definiteness of Matrices? Why and how they are important and related to an optimization problem? **(5)**

b) State the Sylvester's criterion definiteness of a matrix. **(5)**

c) Determine the nature of the quadratic function: **(6)**

$$f(x) = 7x_1^2 + 4x_1x_2 + 10x_1x_3 + 5x_2^2 + 8x_2x_3 + 9x_3^2$$

d) Find the dimensions of a box of largest volume that can be inscribed in a sphere of radius r using the method of constrained variation. **(9)**

4.a) What are the disadvantages of the method of direct substitution and constrained variation in optimization problem with equality constraints? **(04)**

b) Formulate the method of Lagrange multiplier for problems with equality constraint for a simple case of two variables and one constraint. Expand the formulation to explain the necessary condition for a general problem. **(09)**

c) Find the dimensions of a cylindrical tin (with top and bottom) made up of sheet metal to maximize its volume such that the total surface area is equal to $A_0 = 24\pi$. Use the method of Lagrange multiplier with necessary and sufficient conditions. **(12)**