B.Sc. in EEE, 1st Semester

30 November, 2022
10:00 am – 1:00 pm

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

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

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

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are 6 **(Six)** questions. Answer **all the** questions. Question 2(a) and 2(b) have **alternatives**. Marks of each question and corresponding COs and POs are written in the brackets. Assume any data if necessary.

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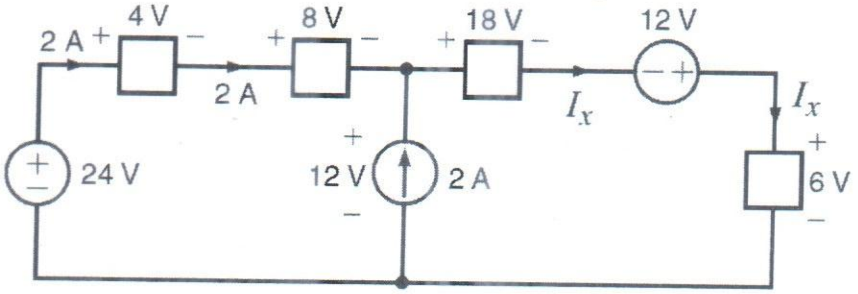
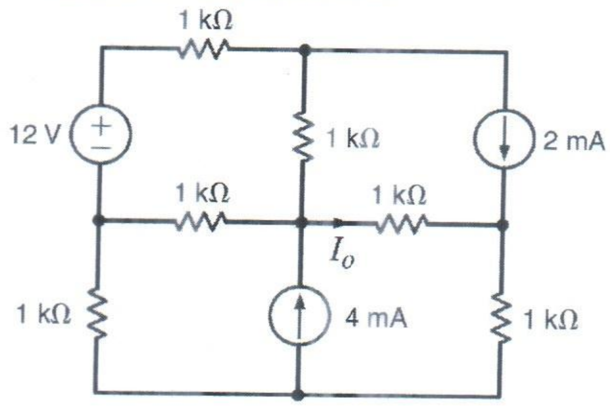
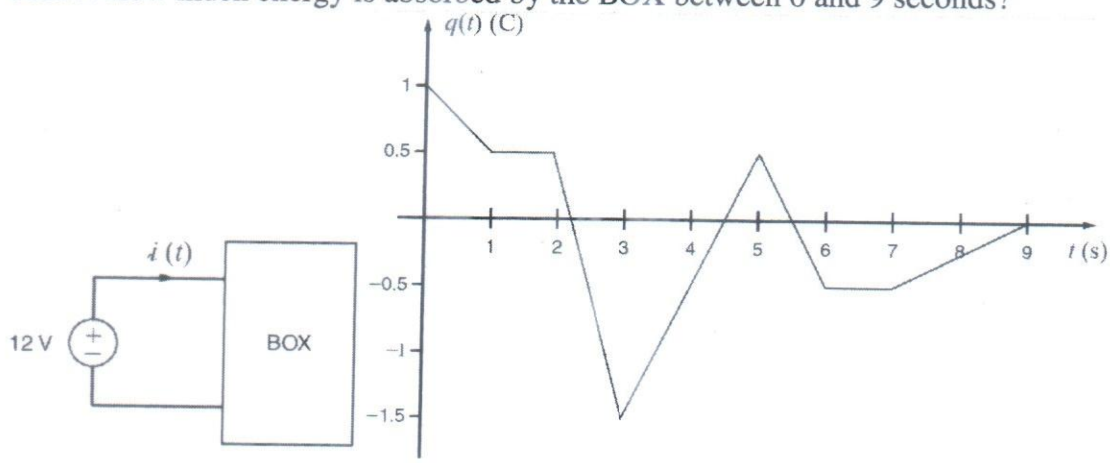
1(a) Find $I_x$ in the circuit in the following figure using Tellegen's theorem. 6 (CO1) (PO1)



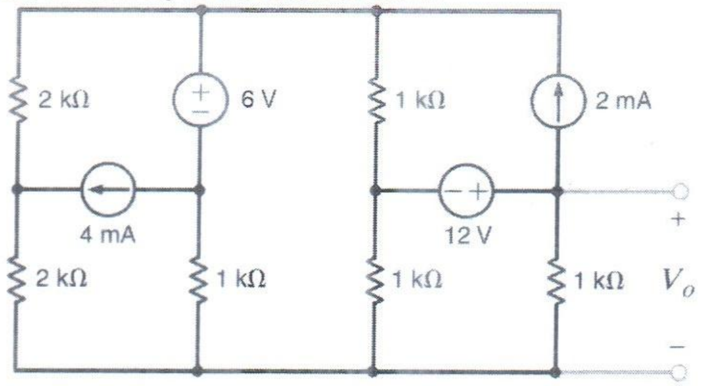

1(b) Use loop analysis to find $I_0$ in the network below. 12 (CO2) (PO2)



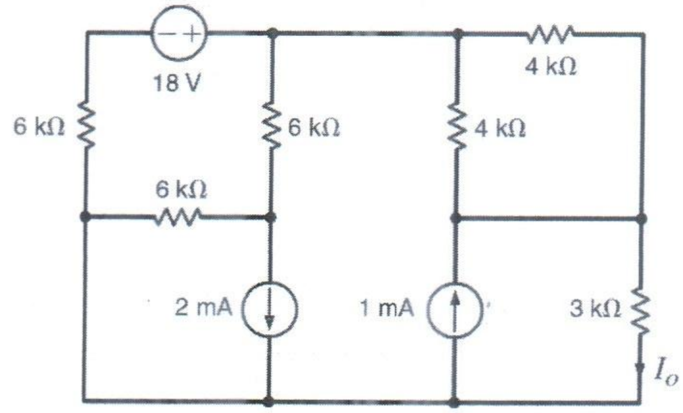

1(c) The charge entering the upper terminal of the BOX in the following figure is shown below. How much energy is absorbed by the BOX between 0 and 9 seconds? 7 (CO1) (PO1)



2(a) Use nodal analysis to find $V_0$ in the circuit below. 13 (CO2) (PO2)

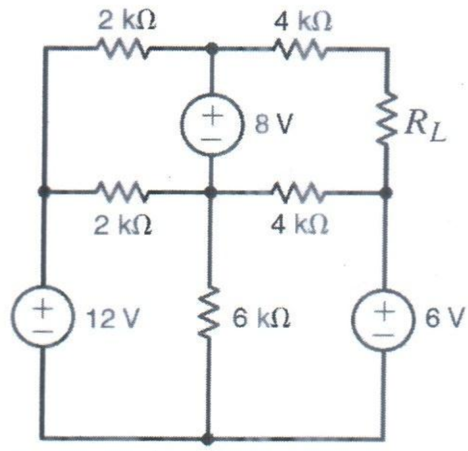



2(b) Use Thévenin's theorem to find $I_0$ in the network in the following figure 12 (CO2) (PO2)

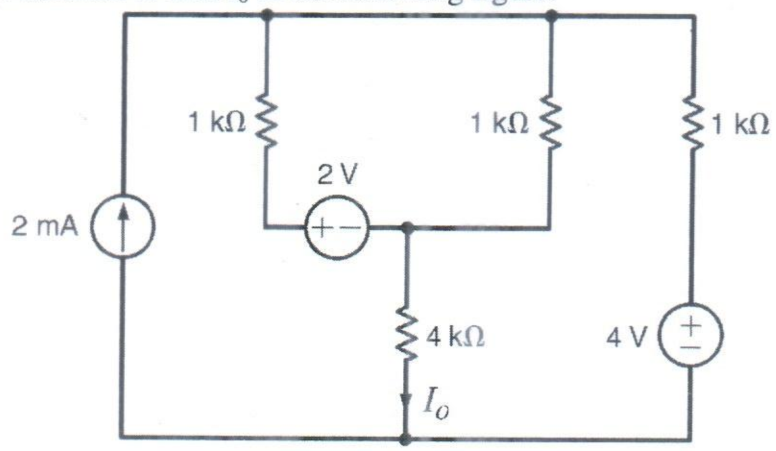



**OR**

2(a) Find the value of $R_L$ in the following figure for maximum power transfer and the maximum power that can be dissipated in $R_L$. 13 (CO2) (PO2)



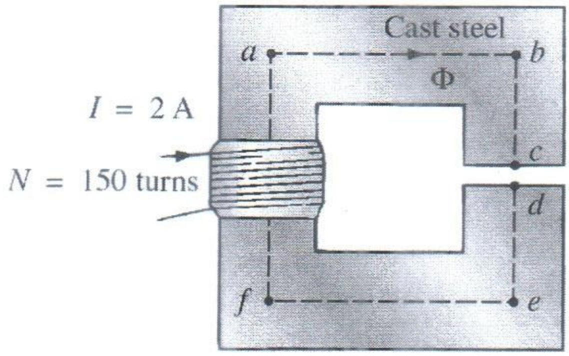

2(b) Use Norton's theorem to find $I_0$ in the following figure. 12 (CO2) (PO2)



3(a) Explain the following terms 12 (CO5) (PO1)

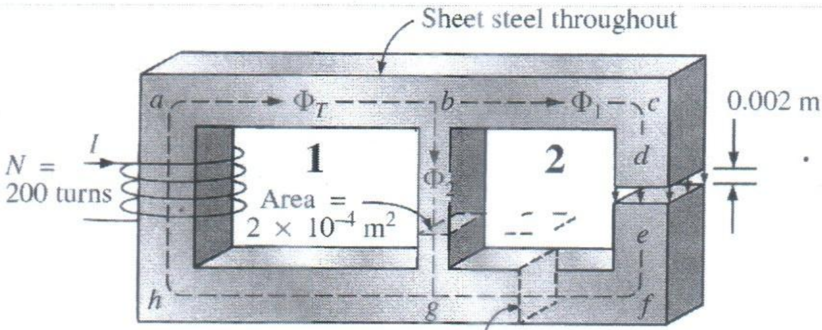
i. Reluctance
ii. Magnetizing force
iii. Hysteresis
iv. Ampere's circuital law
v. Fringing
vi. Permittivity

3(b) Determine the magnetic flux φ established in the series magnetic circuit given in the following figure. 13 (CO5) (PO1)



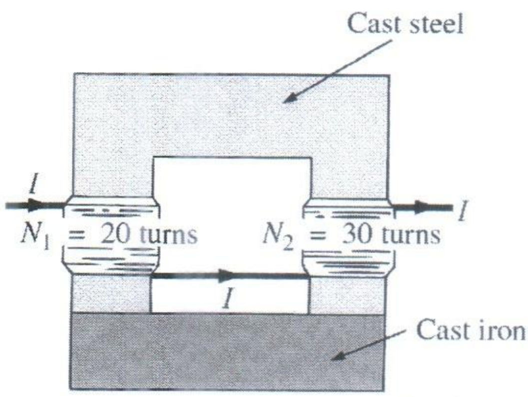

$l_{cd} = 8 \times 10^{-4}$ m
$l_{ab} = l_{be} = l_{ef} = l_{fa} = 0.2$ m
Area (throughout) $= 2 \times 10^{-4}$ m$^2$
$l_{bc} = l_{de}$

4(a) For the series-parallel magnetic circuit in the following figure, find the value of I required to establish a flux in the gap of $\varphi(g) = 2\times10^{-4}$ Wb. 13 (CO5) (PO1)




Area for sections other than $bg = 5 \times 10^{-4}$ m$^2$
$l_{ab} = l_{bg} = l_{gh} = l_{ha} = 0.2$ m
$l_{bc} = l_{fg} = 0.1$ m, $l_{cd} = l_{ef} = 0.099$ m

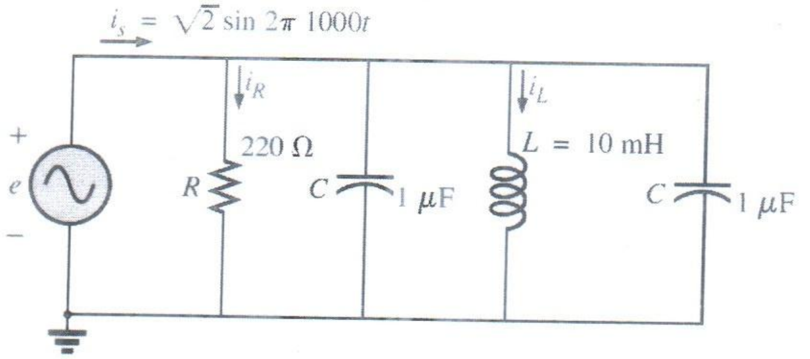
4(b) For the series magnetic circuit in the following figure with two impressed sources of magnetic "pressure," determine the current I. Each applied mmf establishes a flux pattern in the clockwise direction. 12 (CO5) (PO1)




$\Phi = 0.8 \times 10^{-4}$ Wb
$l_{\text{cast steel}} = 5.5$ in.
$l_{\text{cast iron}} = 2.5$ in.

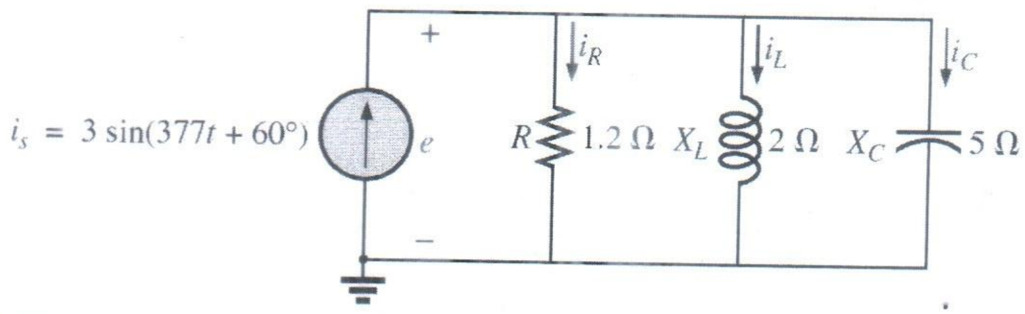
Area (throughout) = 0.25 in.$^2$

5(a) For the network in the following figure 13 (CO4) (PO2)




i. Calculate E, $I_R$, and $I_L$ in phasor form.
ii. Calculate the total power factor, and indicate whether it is leading or lagging.
iii. Calculate the average power delivered to the circuit.
iv. Draw the admittance diagram.
v. Draw the phasor diagram of the currents $I_s$, $I_R$, and $I_L$, and the voltage E.
vi. Find the current $I_C$ for each capacitor using only Kirchhoff's current law.
vii. Find the series circuit of one resistive and reactive element that will have the same impedance as the original circuit.

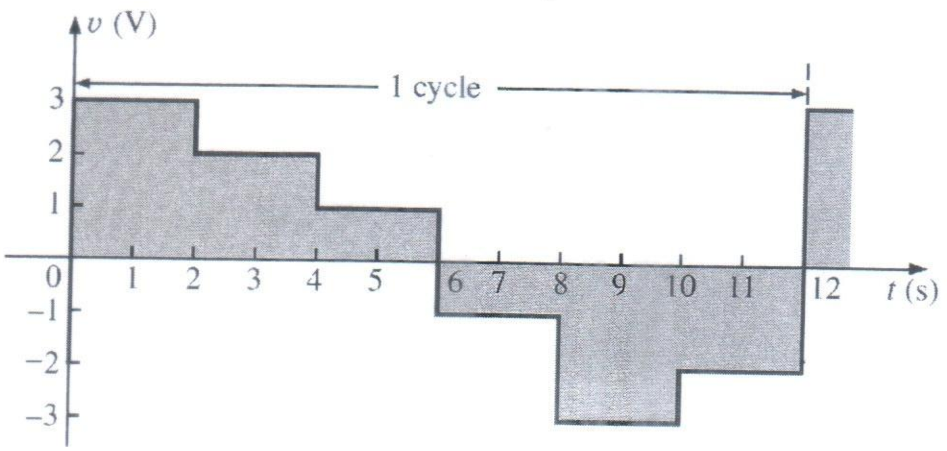
5(b) For the circuit in the following figure 12 (CO4) (PO2)



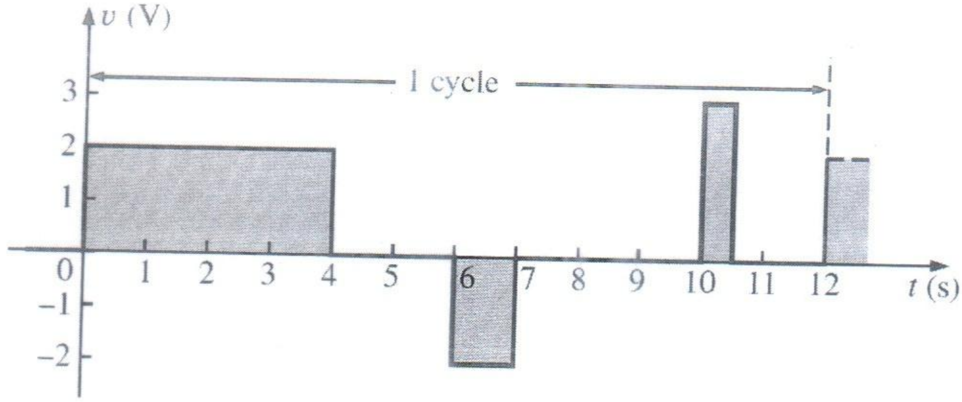

i. Find the total admittance and impedance in polar form.
ii. Draw the admittance and impedance diagrams.
iii. Find the value of C in microfarads and L in henries.
iv. Find the voltage E and currents $I_R$ , $I_L$ , and $I_C$ in phasor form.
v. Draw the phasor diagram of the currents $I_s$ , $I_R$ , $I_L$ , and $I_C$ , and the voltage E.
vi. Verify Kirchhoff's current law at one node.
vii. Find the average power delivered to the circuit.
viii. Find the power factor of the circuit, and indicate whether it is leading or lagging.

6(a) Find the average and rms value of the following periodic waveforms over one full cycle. 12 (CO3) (PO1)

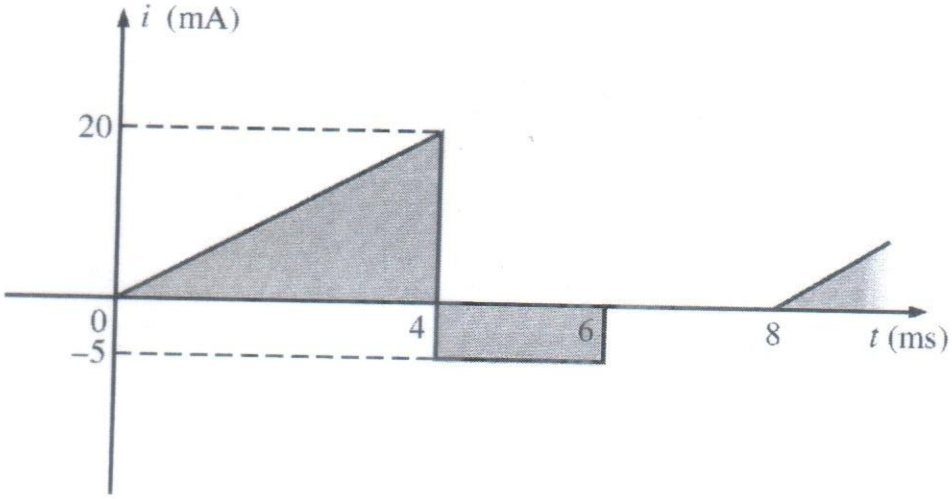
i.



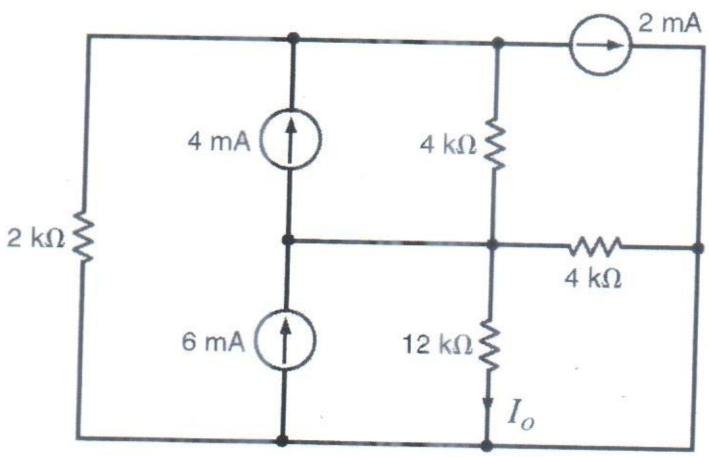
ii.

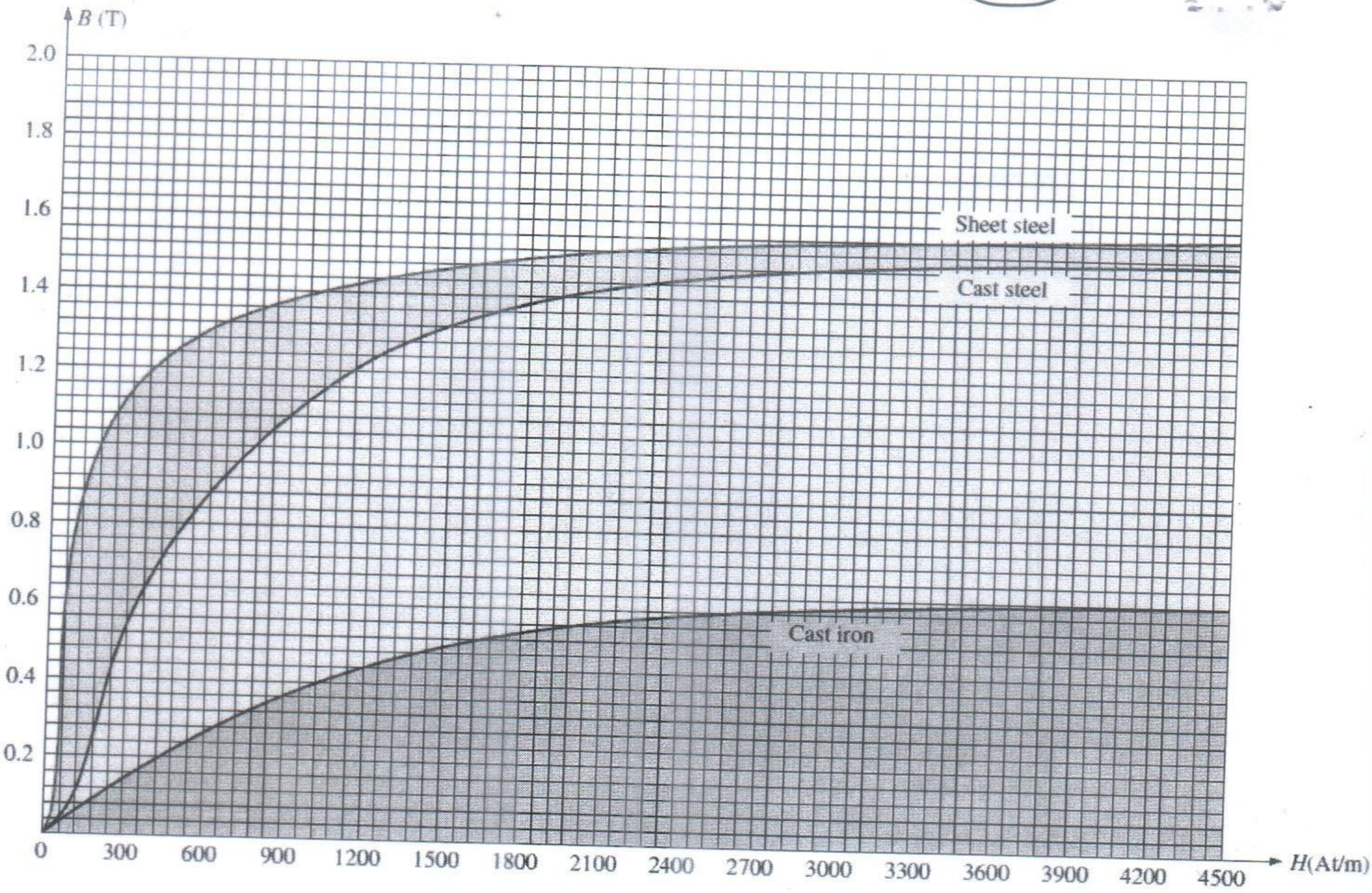



iii.




6(b) Use superposition theorem to find $I_0$ in the network below. 13 (CO2) (PO2)




B (T)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
3900
4200
4500
H(At/m)
Sheet steel
Cast steel
Cast iron

(148)

**B. Sc. in EEE, 1st Semester**

**12 December 2022**
**Time: 10.00 AM– 1:00 PM**

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

**Semester Final Examination**
**Course Number: Phy 4121**
**Course Title: Engineering Physics I**

**Winter Semester: 2021 - 2022**
**Full Marks: 150**
**Time: 3 Hours**

There are **6 (Six)** questions. The symbols have their usual meanings. Answer <u>**ALL**</u> questions. Marks of each question and the corresponding CO and PO are written in brackets.

## Sec A

**1. (a)** Explain the origin of magnetic moment at the atomic level. Evaluate the magnetic moment of an electron in the first Bohr orbit. Briefly describe the classification of magnetic materials. [10] (CO1, PO1)

**(b)** Define the terms permeability ($\mu$), susceptibility ($\chi$), magnetic induction ($B$), magnetic field ($\boldsymbol{H}$), and magnetization ($\boldsymbol{M}$) with reference to magnetism. Formulate a relation between magnetic susceptibility, magnetization, and magnetic field. [10] (CO2, PO1)

**(c)** Illustrate $\boldsymbol{M}$ as a function of **H** behaviour for typical ferro/ferrimagnetic materials. Indicate the coercive field and remanent magnetization. [5] (CO3, PO2)

**2. (a)** Indicate the successes and failures of Classical- and Quantum- free electron theories. Describe how the energy band is formed in a solid. [10] (CO1, PO1)

**(b)** Illustrate the energy bands of metal, insulator, and semiconductor? Mention the classification of semiconductors with some examples. Derive expressions for the conductivity of extrinsic semiconductors. Explain the effect of temperature on the conductivity of semiconductors. [10] (CO3, PO2)

**(c)** Show the rectangular potential wells and barriers, as assumed by Kronig and Penney for a one-dimensional lattice. Sketch the band diagrams of p-type and n-type semiconductors. [5] (CO3, PO2)

**3. (a)** Define superconductors. Sketch resistivity versus temperature graphs for typical superconductors and a perfect conductor. Explain Meissner effect and penetration depth. [10] (CO1, PO1)

**(b)** How the Cooper pair is formed in a superconductor? Mention a few applications of superconductors. Briefly explain the working of a cryotron. [10] (CO2, PO1)

(c) The critical field for niobium is $1 \times 10^5$ amp/m at 8 K and $2\times10^5$ amp/m at absolute zero. Evaluate the transition temperature, $T_c$, of the element. [5] (CO3, PO2)

## Sec B

4. (a) Show that in a Fraunhoffer diffraction experiment, due to double slit, the angular separation between any two consecutive minima or maxima is inversely proportional to the distance between two slits. [10] (CO4, PO1)

(b) How can you distinguish between resolution and magnification of an optical instrument? [05] (CO4, PO1)

(c) "The smallest detail that can be resolved using an optical microscope is about the same size as the wavelength of light being used", justify this statement. [10] (CO4, PO1)

5. (a) Why light waves can be polarized? Briefly describe the different ways to produce polarize light. [10] (CO5, PO1)

(b) State Brewster's law for the polarization of light. [05] (CO5, PO1)

(c) What is double refraction phenomenon in a Calcite crystal? Explain the working principle of a Nicol prism. [10] (CO5, PO1)

6. (a) Define the terms, optical activity and specific rotation. Write down some of the industrial application of optically active materials. [10] (CO6, PO1)

(b) How does the output current of a photoelectric cell depend on the frequency and intensity of light? [05] (CO6, PO1)

(c) Explain the construction and operation of a photo emissive cell. How are photoelectric cells used for reproducing sound in cinematography? [10] (CO6, PO1)

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B.Sc. in EEE, 1st Semester. December 06, 2022

10.00 am - 1:00 pm

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

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

Semester Final Examination — Winter Semester, A. Y. 2021-2022
Course No.: Math 4121 — Time: 3 Hours
Course Title: Mathematics I — Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) Explain first derivative test and higher derivative test for the maximum and minimum of a function with examples for each case. (12) (CO1) (PO1)

   b) Define different indeterminate forms. Explain how to evaluate these forms. Evaluate $\underset{x\to 0}{Lt}(\cos x)^{\cot^2 x}$. (13) (CO1) (PO1)

2. a) If $u=\ln(x^2+y^2+z^2)$, calculate the value of $x\frac{\partial^2 u}{\partial y\partial z}+y\frac{\partial^2 u}{\partial z\partial x}+z\frac{\partial^2 u}{\partial x\partial y}$ given that x=y=z=1. (12) (CO2) (PO2)

   b) Develop the formula of the radius of curvature of the curve whose parametric equations are x = x(t), y = y(t). Also find the radius of curvature of the curve $x=a(\theta+\sin\theta), y=a(1-\cos\theta)$ at $\theta=\frac{1}{4}\pi$ (13) (CO3) (PO2)

3. a) Solve the following: (12) (CO1) (PO1)

   i) $\int\frac{5x+9}{\sqrt{2x^2+3x+4}}dx$ ii) $\int x\sqrt{\left(\frac{a-x}{a+x}\right)}dx$

   b) Find the reduction formula for $I_{m,n}=\int\cos^m x\cos nx dx$, hence find $\int\cos^2 x\cos 2x dx$. (13) (CO1) (PO1)

4. a) Write down the properties of definite integrals. (12) (CO1) (PO1)

   Prove that $\int_a^b f(x)dx=\int_a^b f(a+b-x)dx$ and use it to evaluate the integral $\int_0^a (a^2-2ax+x^2)^{100}dx$.

b) Evaluate the following definite integrals (13) (CO1) (PO1)

i) $\int_0^{\frac{\pi}{2}} \ln\sqrt{\cos x}\,dx$ ii) $\int_0^1 x^4\sqrt{1-x^2}\,dx$

5. a) Show that $\int_0^{\frac{\pi}{2}} \frac{\sin^{2m-1}\theta\cos^{2n-1}\theta\,d\theta}{(a\sin^2\theta+b\cos^2\theta)^{m+n}} = \frac{\Gamma(m)\Gamma(n)}{2a^m b^n\Gamma(m+n)}$ (8) (CO2) (PO2)

b) Evaluate $\int_1^2 \frac{e^{\sqrt{x-2}}}{\sqrt{x}+1}dx$ by Simpson's rule taking 8 subintervals. (8) (CO2) (PO2)

c) Find the area of the loops of the curve $r = 100\cos 100\theta$ (9) (CO3) (PO2)

6. a) Find the perimeter of the hypo-cycloid $\left(\frac{x}{a}\right)^{\frac{2}{3}} + \left(\frac{y}{b}\right)^{\frac{2}{3}} = 1$ (12) (CO3) (PO2)

b) The arc of the hypocyloid $x = a\cos^3\theta$, $y = b\sin^3\theta$ from $\theta = 0$ to $\theta = \frac{\pi}{2}$ revolves about y-axis. Find the volume of the solid generated. (13) (CO3) (PO2)

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B.Sc. in EEE, 1st Semester

**Date:** 14 December, 2022
**Time:** 10:00 am – 1.00 pm

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

Semester Final Examination
Course No.: Chem 4121
Course Title: Engineering Chemistry

Winter Semester, A. Y. 2021-2022
Time: 3 hours
Full Marks: 150

There are **6 (six)** questions answer **all** of them. 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) Derive Schrodinger equation and explain the significance of $\psi^2$. 8 (CO3, PO2)

b) Explain Heisenberg's uncertainty principle. "It is only application for microscopic particles". Justify the answer with proper reasoning. 7 CO2, PO1)

c) Derive an equation for determining the molecular mass of solute by applying Raoult's Law of lowering of vapor pressure.
The boiling point of an aqueous solution containing 3.5 g urea (MW. 60.0) in 50.0 g water 101.5 0C. Calculate boiling point elevation constant. 10 (CO4, PO2)

2 a) Explain at constant temperature heat change of a system is equal to enthalpy change. 7 (CO2, PO1)

b) Ionization energy is a periodic function, Justify. What are the anomalies observed for ionization energy across the period? explain the reasons. 8` CO3, PO2)

c) Explain molecular orbital theory (MOT). Apply MOT to draw the molecular orbital diagram of CO, write molecular electronic diagram, find out bond order and states magnetic behavior of CO. 10 (CO4, PO2)

3 a) Explain different types of chemical reaction with examples. 7 (CO1, PO1)

b) Discuss_the effect of temperature on the rate of reaction 8 CO3, PO2)

c) Hydrolysis of ethyl acetate by NaOH using equal concentration of the reactants, was studied by titrating 25ml of the reaction mixture at different time intervals against standard acid and the data are given below, 10 (CO4, PO2)

| t (min) | 0 | 5 | 15 | 25 |
|---|---|---|---|---|
| remain base(mL) | 16.00 | 10.24 | 6.13 | 4.32 |

Calculate_the order of the reaction and find out the relation between the half-life and the initial for the above reaction.

| | | | | |
|---|---|---|---|---|
| 4 | a) | Describe the factors accelerating the corrosion of metal and the methods of prevention of corrosion. | 7 | (CO2, PO1) |
| | b) | Derive Nernst-equation.<br>Calculate the cell potential of the following voltaic cell at 25$^0$C?<br>Zn($s$)\|$Zn^{2+}$ (0.200 $M$)\|\|$Ag^+$ (0.00200 $M$)\|Ag($s$), the reduction potential of Zn and Ag is given -0.76 V and 0.80 V, respectively. | 8 | CO3, PO2) |
| | c) | Design a fuel cell. Describe working principle and advantage of your designed fuel cell. | 10 | (CO4, PO2) |
| 5 | a) | Classify liquid crystals and briefly discuss them. | 7 | (CO2, PO1) |
| | b) | Derive van't Hoff equation and explain variation of equilibrium constant with temperature. | 8 | CO3, PO2) |
| | c) | Derive an equation for the determination of pH of an acidic buffer solution.<br>Calculate the pH of a buffer solution made from 0.20 M $HC_2H_3O_2$ and 0.50 M $C_2H_3O_2^-$ that has an acid dissociation constant for $HC_2H_3O_2$ of 1.8 x $10^{-5}$. | 10 | (CO4, PO2) |
| 6 | a) | Derive an equation for the determination of pH for an acidic buffer. | 7 | (CO2, PO1) |
| | b) | Describe_Kohlrausch's law and write down its significance. | 8 | CO3, PO2) |
| | c) | Describe an experiment for measuring the molar conductance of a solution. The resistance of 0.1N solution of a salt occupying a volume between two platinum electrodes 1.80 cm apart and 5.4 $cm^2$ in area was found to be 32 ohms. Calculate the equivalent conductance of the solution. | 10 | (CO4, PO2) |

B.Sc. in EEE, 1st Semester

December 08, 2022
10.00 am – 1:00 pm

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

## DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

**Semester Final Examination**
**Course Number: Math-4123**
**Course Title: Mathematics II**

**Winter Semester: 2021-2022**
**Full Marks: 150**
**Time :3 Hours**

There are **6 (six)** questions. Answer all **6 (six)** 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) Reduce the quadratic form $q = x_1^2 + 5x_3^2 + 4\,x_1x_2 + 6x_1x_3 + 8x_2x_3$ to the canonical form and find the rank, index and signature of the form. **(13) CO2 PO1**

   b) State the Cayley-Hamilton theorem and use this theorem to find the inverse of the matrix $A = \begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$. **(12) CO1 PO1**

2. a) The system of linear differential equations for the currents $i_1(t)$ and $i_2(t)$ in an electrical network is **(15) CO5 PO1, PO2**

$$L_2\frac{di_1}{dt} = -(R_1 + R_2)i_1 + R_2 i_2 + E,$$
$$L_1\frac{di_2}{dt} = R_2 i_1 - R_2 i_2.$$

   Use matrix method to solve the system if $R_1$ = 24 ohms, $R_2$ = 9 ohms $L_1$ = 3 henry, $L_2$ = 3 henry and E = 300 volts, $i_1(0) = i_2(0) = 0$.

   b) Solve the following boundary value problem which arises in the heat condition in a rod $c^2\frac{\partial^2 u}{\partial x^2} = \frac{\partial u}{\partial t}$, under the conditions: **(10) CO5 PO1, PO2**

$$u(0,t) = u(20,t) = 0, u(x.0) = sin\left(\frac{\pi x}{20}\right).$$

3. Solve the following differential equations

   a) $[D^3 - 3D^2 + 4D - 2)]y = e^x - 2x^2.$ **(8) CO3 PO1, PO2**

   b) $[D^2 + 2D + 1)]y = e^x sinx.$ **(8) CO3 PO1, PO2**

   c) $x^3\frac{d^3y}{dx^3} + 2x^2\frac{d^2y}{dx^2}^2 + 3x\frac{dy}{dx} - 3y = x^2.$ **(9) CO3 PO1, PO2**

4. a) Solve: $x^2p^2 + x(3y - 4x^2)p + 2y^2 - 4x^2y = 0$. **(8) CO3 PO1, PO2**

b) Solve: $(x+1)\frac{d^2y}{dx^2} + x\frac{dy}{dx} - \frac{dy}{dx} - 2y = 0$ by the method of factorization of the operator. **(8) CO3 PO1, PO2**

c) Solve the system of linear differential equations **(9) CO3 PO1, PO2**

$$\frac{dx}{dt} + \frac{dy}{dt} + 2x + y = cos2t, \qquad \frac{dy}{dt} + 5x + 3y = 0.$$

5. a) Find the partial differential equation by eliminating the arbitrary functions from the equation $\varphi(x + y + z, x^2 + y^2 - z^2) = 0$. **(8) CO1 PO1**

b) Solve: $y^2p - xyq = xy - zx$. **(8) CO4 PO1, PO2**

c) Solve: $(z^2 - 2yz - y^2)p + (xy + xz)q = xy - zx$. **(9) CO4 PO1, PO2**

6. a) Find the complete integral and singular integral of **(8) CO4 PO1, PO2**

$$px + qy = pq.$$

b) Solve: $(D_x^2 - D_xD_y - 2D_y^2)z = 12x^2 + e^{3x+y}$. **(8) CO4 PO1, PO2**

c) Derive the Laplace equation in cylindrical co-ordinate from Cartesian co-ordinate. **(9) CO4 PO1, PO2**

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

Semester Final Examination
Course No.: PHY 4143
Course Title: Physics II

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) Find the equivalent capacitance of the network in Fig. 1(a) from terminal a-b. **10 (CO2, PO1, PO2)**

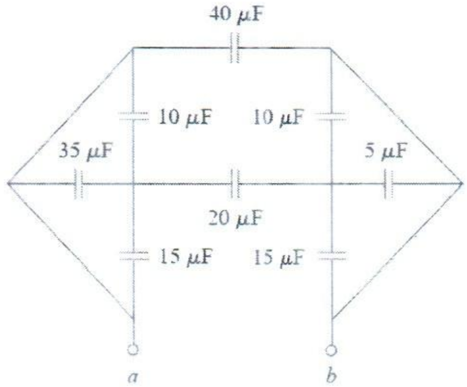


Fig. 1(a)

b) For the circuit in Fig. 1(b), if $i_s = 3e^{-t}\ mA$, find – **10 (CO2, PO1, PO2)**

i. $L_{eq}$
ii. $i_1(t)$ and $i_2(t)$
iii. $v_o(t)$
iv. energy stored in the 20mH inductor at 1s.

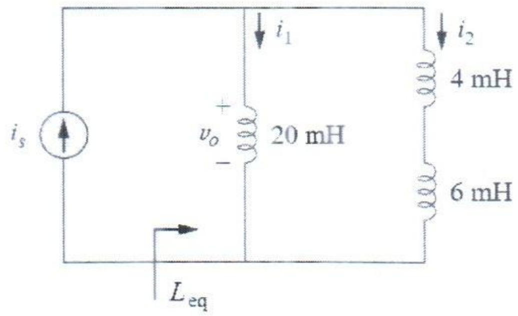


Fig. 1(b)

c) Justify why inductor acts as a short circuit in the application of dc voltage. **5 (CO1, PO1)**

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2. a) Find the value of Z in the network given in Fig. 2(a) where, $V_0 = 4\angle 0^0 V$. **10 (CO2, PO1, PO2)**

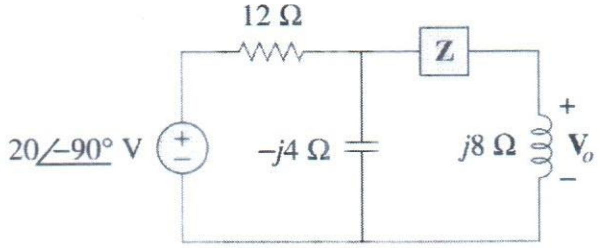


Fig. 2(a)

b) For the circuit in Fig. 2(b), find $Z_T$ *and* $V_{ab}$. **10 (CO2, PO1, PO2)**

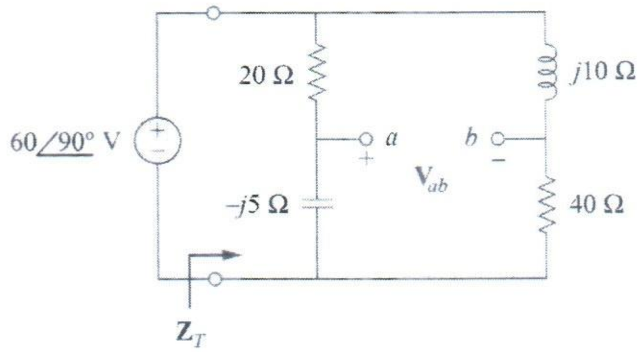


Fig. 2(b)

c) Sketch the phasor diagram representing voltage-current relationship for an inductor and a capacitor. **5 (CO1, PO1)**

3. a) For the circuit in Fig. 3(a), find $v_1$ *and* $v_2$ using Nodal analysis. **10 (CO2 PO1, PO2)**

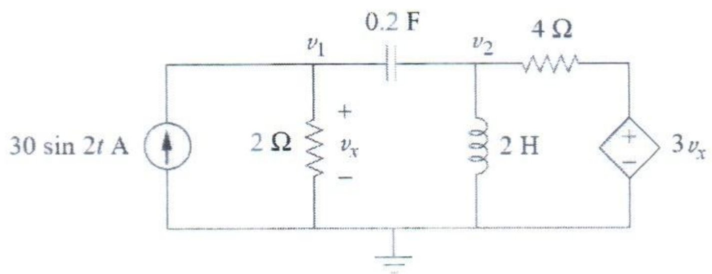


Fig. 3(a)

b) For the circuit in Fig. 3(b), find $V_0$ using Mesh analysis. **10 (CO2, PO1, PO2)**

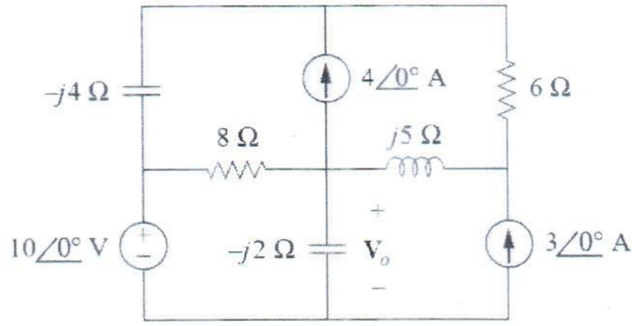


Fig. 3(b)

c) For the circuit in Fig. 3(c), find $V_x$ using Source transformation. **5 (CO2) (PO1, PO2)**

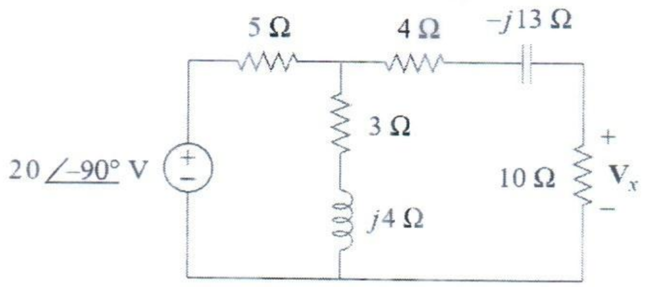


Fig. 3(c)

4. a) For the circuit in Fig. 4(a), find $i_0$. **15 (CO2) (PO1, PO2)**

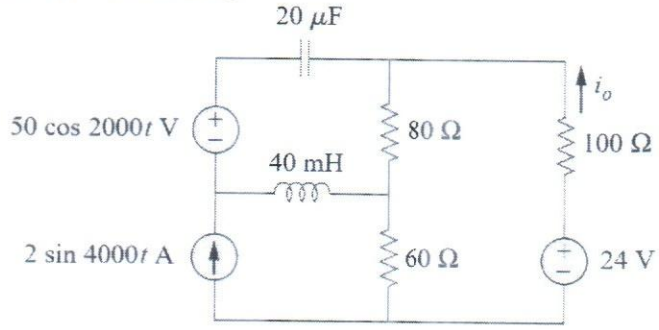


Fig. 4(a)

b) Find Thevenin equivalent of the circuit in Fig. 4(b) from terminal a-b. **10 (CO2) (PO1, PO2)**

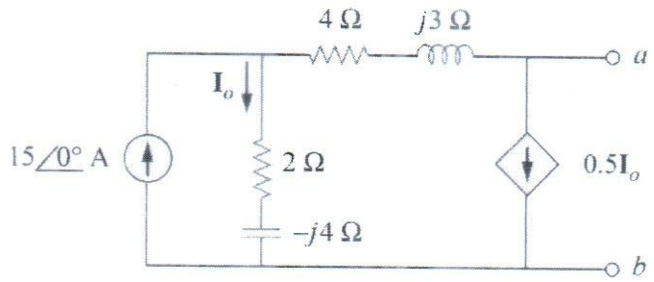


Fig. 4(b)

5. a) For the circuit in Fig. 5(a), calculate resonant frequency, half-power frequencies, Quality factor, and Bandwidth. **10 (CO2, PO1, PO2)**

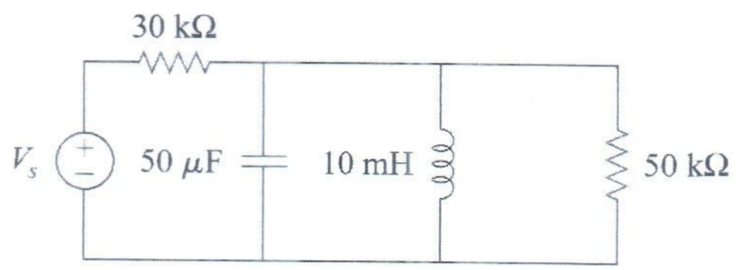


Fig. 5(a)

b) Find resonant frequency for the circuit in Fig. 5(b). **10 (CO2, PO1, PO2)**

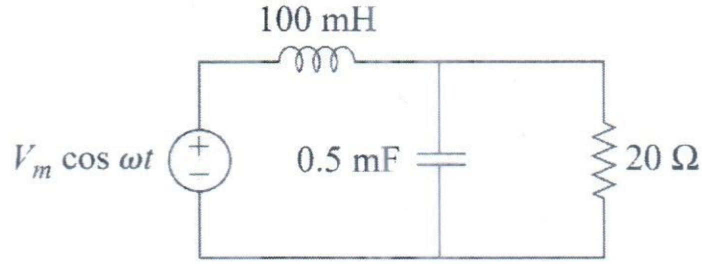


Fig. 5(b)

c) Explain the concept of resonance in electric network. **5 (CO1, PO1)**

6. a) Find what does the Quality factor of a resonant circuit indicate and how this concept is applied in practical applications. **5 (CO1, PO1)**

b) Design and explain the operation of a Band-stop filter. **5 (CO1, PO1)**

c) From three signals with frequencies 2 KHz, 2.2 KHz, and 1.8 KHz, if you want to isolate the 2.2 KHz channel, what type of filter do you need – justify your answer. How can you design such a filter? **5 (CO1, PO1)**

d) Identify what type of filter the circuit in Fig. 6(d) represents and determine its cut-off frequency. Also find its transfer function. Assume, R1= R2= 100 Ω, and L=2 mH. **10 (CO2, PO1, PO2)**

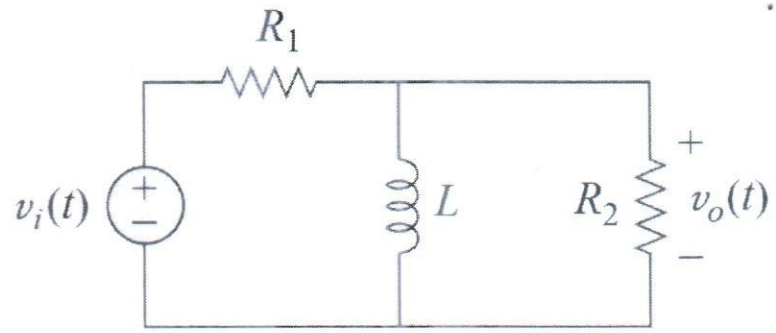


Fig. 6(d)

BBA in TM, 1st semester

Date: 14th December, 2022
Time: 10:00 am–1:00 pm

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

**Semester Final Examination**
**Course Number: EEE 4161**
**Course Title: Electrical and Electronic Technology I**

**Winter Semester: 2021- 2022**
**Full Marks: 150**
**Time: 3 Hours**

There are **06 (six)** questions. Answer all **06 (six)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

**1.** a) How many basic S.I. units are there? List them. **(05) (CO1, PO1)**

b) Explain the working principle of simple loop DC generator. **(07) (CO1, PO1)**

c) i. The current flowing through an element is **(13) (CO1, PO1)**

$$i = \begin{cases} 4\text{ A}, & 0 < t < 1 \\ 4t^2\text{ A}, & t > 1 \end{cases}$$

Calculate the charge entering the element from t= 0 s to t= 2 s.

ii. How much energy does a 100 W electric bulb consume in two hours?

**2.** a) What do you understand by the resistance of a material? List out the factors that affect the resistance of a material. **(03) (CO1, PO1)**

b) State Ohm's law. Illustrate Ohm's law for a linear resistor. **(04) (CO1, PO1)**

c) i. Identify the nodes in the circuit in figure 2(c). **(08) (CO1, PO1)**

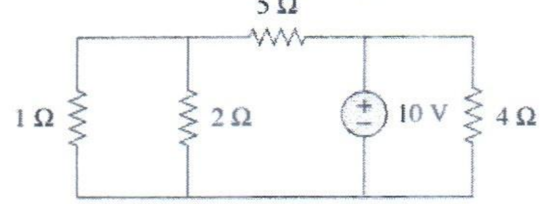


figure 2(c)

ii. For the circuit in figure 2(c), find out the potential difference across each of the linear resistors using voltage division method.

d) i. Find $v_x$ and $v_0$ from the circuit in figure 2(d). **(10) (CO1, PO1)**

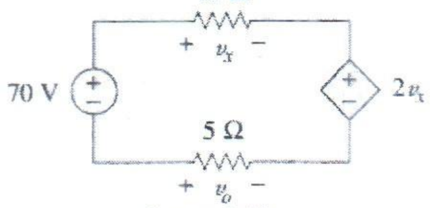


figure 2(d)

**3.** a) Determine $v_x$ and the power absorbed by the 12 ohm resistor in figure 3(a). **(12) (CO1,PO1)**

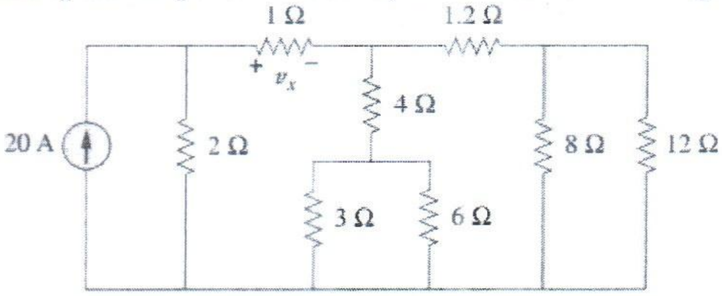


figure 3(a)

b) Transform the circuit in figure 3(b) from Delta to Wye. **(06) (CO1, PO1)**

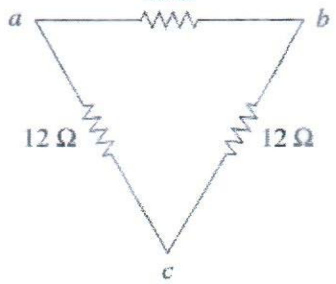


figure 3(b)

c) Find out the mesh currents from the circuit in figure 3(c). **(07) (CO1, PO1)**

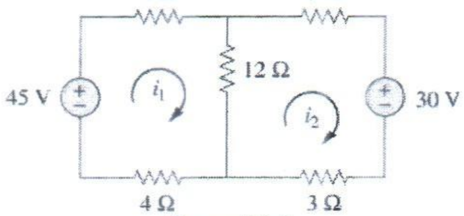


figure 3(c)

**4.** a) Under DC conditions, find the voltage across the capacitors in figure 4(a). **(10) (CO1, PO1)**

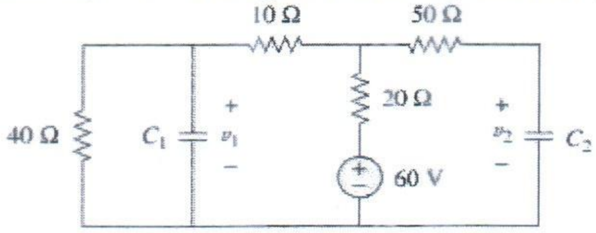


figure 4(a)

b) Find the equivalent capacitance seen at the terminals of the circuit in figure 4(b). **(05)** **(CO1, PO1)**

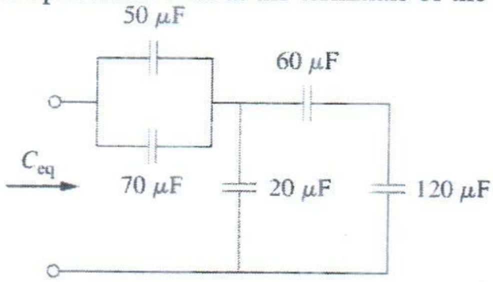


figure 4(b)

c) Calculate the line currents in the three-wire Y-Y system in figure 4(c). **(10)** **(CO1, PO1)**

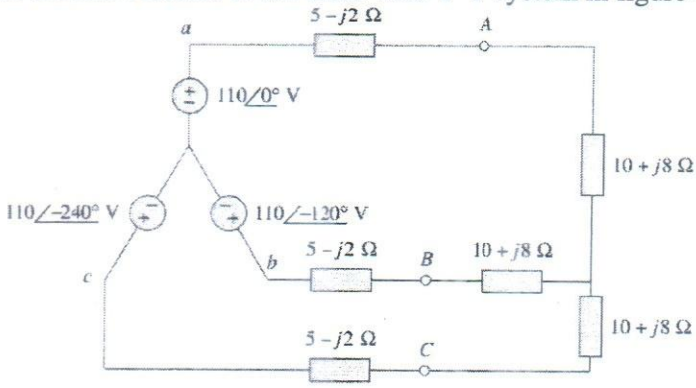


figure 4(c)

**5.** a) For the sinusoid 30sin(4πt-75°), calculate its amplitude, phase, angular frequency, period, and frequency. **(08)** **(CO1, PO1)**
What are the three differences between instantaneous voltage and phasor voltage?

b) Evaluate these complex numbers: **(03)** **(CO1, PO1)**

$$\frac{10\angle -30^\circ + (3 - j4)}{(2 + j4)(3 - j5)^*}$$

c) State the time-domain and frequency (phasor) domain relationship between voltage and current for a resistor, inductor and capacitor. You should use formulae/expressions to for illustration. **(03)** **(CO1, PO1)**

d) Determine $v_o$(t) in the circuit represented in figure 5(d). **(11)** **(CO1, PO1)**

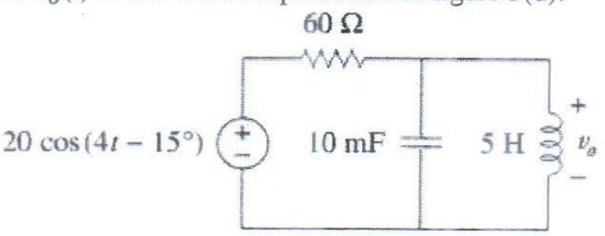


figure 5(d)

6. a) Find $i_x$ from figure 6(a), using nodal analysis. **(12) (PO1, CO1)**

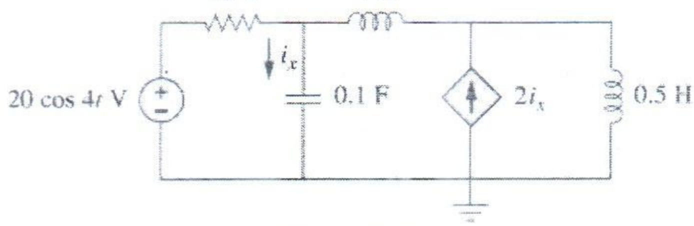


figure 6(a)

b) Determine the power factor of the circuit in figure 6(b), as seen by the source. **(08) (PO1, CO1)**

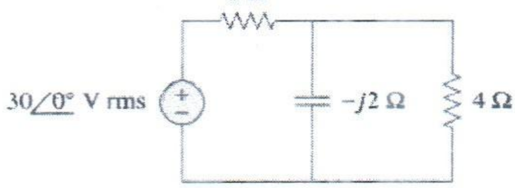


figure 6(b)

c) The current through a 0.1 H inductor is $i(t)=10te^{-5t}$ A. Find the voltage across the inductor and the energy stored in it. **(05) (PO1, CO1)**

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

December 09, 2022
10:00 am – 1:00 pm

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

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

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

Winter Semester, A.Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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. Assume reasonable value for any missing data, if it is required.

---

1. a) State the necessity of bus-bar and discuss the different types of bus-bar arrangements. The three bus-bar conductors in an outdoor sub-station are supplied by units of post insulators. Each unit consists of a stack of 3-pin insulators fixed one on the top of the other. The voltage across the lowest insulator is 8·45 kV and that across the next is 7·25 kV. Evaluate the bus-bar voltage of the station. [8+7] [CO1] [PO1]

   b) A certain 3-phase equilateral transmission line has a total corona loss of 53 kW at 106 kV and a loss of 98 kW at 110·9 kV. [5×2] [CO2] [PO2]
      i) Determine the disruptive critical voltage.
      ii) Measure the corona loss at 113 kV.

2. a) Two conductors of a single phase line, each of 1 cm diameter, are arranged in a vertical plane with one conductor mounted 1 m above the other. A second identical line is mounted at the same height as the first and spaced horizontally 0·25 m apart from it. The two upper and the two lower conductors are connected in parallel. Find the inductance per km of the resulting double circuit line. [13] [CO2] [PO2]

   b) A 3-phase, 50 Hz, 132 kV overhead line has conductors placed in a horizontal plane 4·56 m apart. Conductor diameter is 22·4 mm. If the line length is 100 km, Calculate the followings, assuming complete transposition: [6×2] [CO2] [PO2]
      i) Capacitance of each conductor to neutral,
      ii) Charging current per phase.

3. a) Using nominal T method, design a 3-phase system for the followings: the current and voltage at the sending end as well as efficiency of transmission considering 110 kV, 50 Hz transmission line of 100 km long which delivers 20 MW at 0·9 p.f. lagging. The resistance and reactance of the line per phase per km are 0·2 Ω and 0·4 Ω respectively, while capacitive admittance is $2{\cdot}5 \times 10^{-6}$ Siemens/km/phase. [5×2+5] [CO3] [PO3]

   b) Calculate A, B, C and D constants of a 3-phase, 50 Hz transmission line 160 km long having the following distributed parameters : [10] [CO2] [PO2]
      $R = 0{\cdot}15\ \Omega/\text{km}$ ; $L = 1{\cdot}20 \times 10^{-3}$ H/km ; $C = 8 \times 10^{-9}$ F/km

4. a) Discuss the relative merits and demerits of underground and overhead systems. Show that in a uniformly loaded distributor fed at one end, the total voltage drop is equal to that produced by the whole of the load assumed to be concentrated at the middle point. [8+7] [CO1] [PO1]

b) The Varley loop test is used to find the position of an earth fault on a line of length 40 km. The resistance/km of a single line is 28 Ω. The fixed resistors have resistances of 250 Ω each. The fault is calculated to be 7 km from the test end. For the system, calculate the value of resistance for the variable resistor set. [10] [CO2] [PO2]

5. a) A single phase ring distributor ABC is fed at A. The loads at B and C are 40 A at 0·8 p.f. lagging and 60 A at 0·6 p.f. lagging respectively. Both power factors expressed are referred to the voltage at point A. The total impedance of sections AB, BC and CA are 2 + j1, 2 + j3 and 1 + j2 ohms respectively. Find the current in each section. [13] [CO2] [PO2]

b) A ring distributor shown in Fig. 5(b) with interconnector BD. The supply is given at point A. The resistances of go and return conductors of various sections are indicated in the figure. Evaluate the followings: [12] [CO2] [PO2]
(i) current in the interconnector,
(ii) voltage drop in the interconnector.

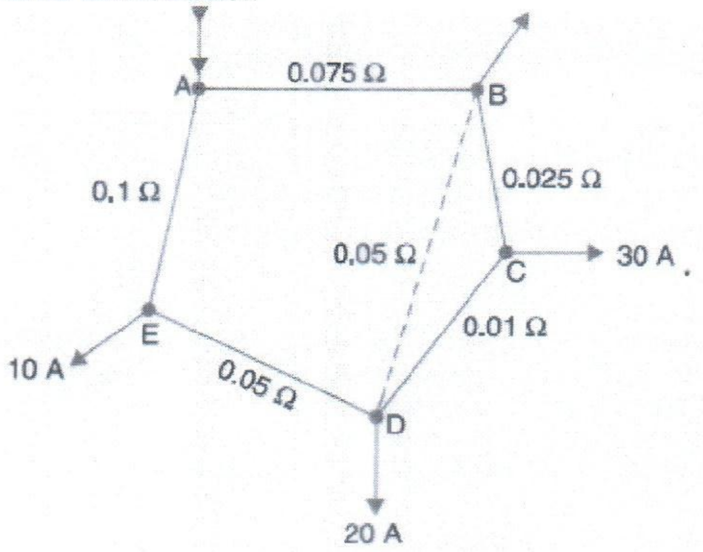


Fig. 5(b)

6. a) A two-wire d.c. distributor AB, 600 metres long is loaded as under : [5×2+3] [CO2] [PO2]

| | | | | |
|---|---|---|---|---|
| Distance from A (metres) : | 150 | 300 | 350 | 450 |
| Loads in Amperes : | 100 | 200 | 250 | 300 |

The feeding point A is maintained at 440 V and that of B at 430 V. If each conductor has a resistance of 0·01 Ω per 100 metres, calculate :
(i) currents supplied from side A as well as side B,
(ii) power dissipated in the distributor.

b) A 3-wire d.c. distributor, 250 m long, is supplied at end P at 500/250 V and is loaded as under : [4×3] [CO2] [PO2]
Positive side : 20 A, 150 m from P ; 30 A, 250 m from P
Negative side : 24 A, 100 m from P ; 36 A, 220 m from P
The resistance of each outer wire is 0·02 Ω per 100 m and the cross-section of the middle wire is one half that of the outer. Determine the voltage across each load point.

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B.Sc. in EEE, 3rd Semester

December 05, 2022
10:00 am – 01:00 pm

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

Semester Final Examination
Course No.: EEE 4303
Course Title: Electronics II

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) Derive the equation of output voltage, $v_O$ of the instrumentation amplifier shown in Fig. 1(b). **12.5 (CO1, PO1)**

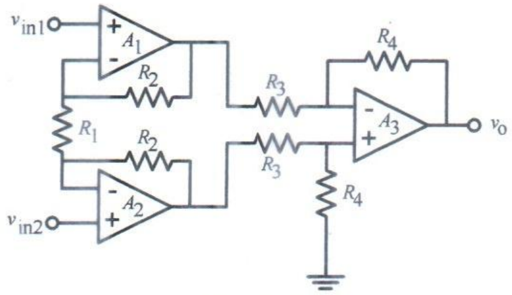


Fig. 1(b)

b) For the instrumentation amplifier in Fig. 1(b), $R_4 = 90$ kΩ, $R_3 = 30$ kΩ and $R_2 = 50$ kΩ. Resistance $R_1$ is a series combination of a fixed 2 kΩ resistor and a 100 kΩ potentiometer. (i) Determine the range of the differential voltage gain. (ii) Determine the maximum current through $R_1$ for input voltages in the range from -25 mV to +25 mV. **12.5 (CO2, PO2)**

2. a) Design a summing op-amp to produce the output $v_O = -10v_{i1} - 4v_{i2} + 5v_{i3} + 2v_{i4}$. The smallest resistor value allowable is 20 kΩ. **12.5 (CO1, PO1)**

b) Consider the two amplifier configurations shown in Fig. 2(b). Assume that $A_1 = 10^4$, $A_2 = 10$ and $\beta = 0.001$. Determine the effect of the noise signal $v_n$. **12.5 (CO2, PO2)**

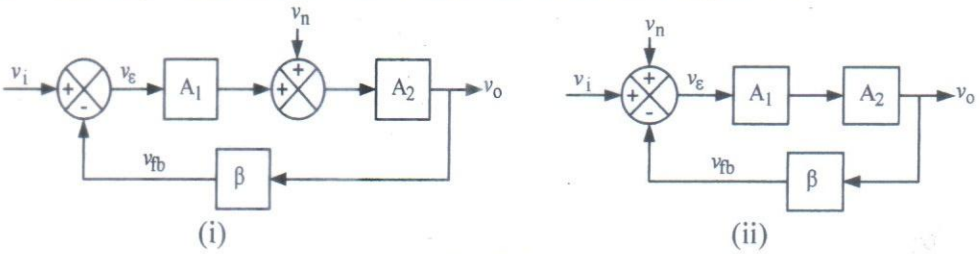


Fig. 2(b)

3. 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. 3(b), obtain the transfer function $H(\omega)$. **12.5 (CO2, PO2)**

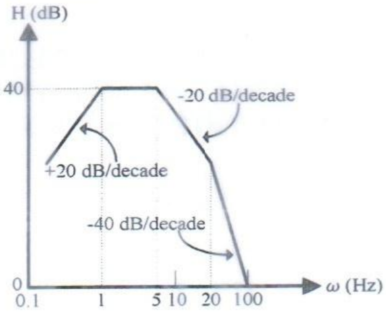


Fig. 3(b)

4. a) Determine the value of $\beta$ that yields a phase margin of 45 degrees and the resulting closed-loop low-frequency gain. Consider a three-pole feedback amplifier with a loop gain function given by $T(f) = \frac{\beta(1000)}{(1+j\frac{f}{10^3})(1+j\frac{f}{5\times10^4})(1+j\frac{f}{10^6})}$. **12.5 (CO1, PO1)**

b) A feedback amplifier has a low-frequency open-loop gain of 4000 and three poles at $f_{P1}$ = 400 kHz, $f_{P2}$ = 4 MHz, and $f_{P3}$ = 40 MHz. A dominant pole is to be inserted such that the phase margin is 60 degrees. Assuming the original poles remain fixed, determine the dominant pole frequency. **12.5 (CO2, PO2)**

5. a) Explain the frequency of oscillation and the condition of oscillation of a Colpitts oscillator. **12.5 (CO1, PO1)**

b) Analyse the phase-shift oscillator in Fig. 5(b). Show that the frequency of oscillation is given by $\omega_0 = \frac{1}{\sqrt{6}RC}$ and that the condition for oscillation is given by $\frac{R_2}{R} = 29$. **12.5 (CO2, PO2)**

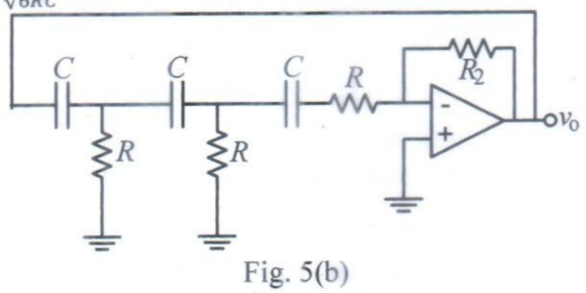


Fig. 5(b)

6. a) Explain the crossover distortion in class-B operation of an amplifier. **12.5 (CO1, PO1)**

b) Analyse the operation of a class-AB complementary BJT push–pull output stage. **12.5 (CO2, PO2)**

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

Date: December 1, 2022 (Thursday)
Time: 10:00 am to 1:00 pm

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

## DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

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

Winter Semester, A.Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **2 (two)** questions. Answer **all 2 (two)** 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) With appropriate sketches, illustrate the interactions of compoles (interpoles) for a 2–pole dc generator with the cross–magnetization component of armature reaction and reactance voltage. (09) (PO1) (CO1)

b) Sketch the curve for generated voltage, $E_0$ of a dc shunt generator during its voltage build up phase under no–load condition. Interpret the different types of energy transfers associated with this process. (09) (PO1) (CO1)

c) Interpret the flux distribution natures in a single–stepped core, double–stepped core, and three–stepped core for a square–type core of a shell–type $1-\varphi$ transformer with appropriate diagrams of the cores and coils. (09) (PO1) (CO1)

d) For a $250\,V$ dc shunt motor, the armature and field resistances are $0.5\,\Omega$ and $250\,\Omega$ repectively. When driving a load of constant torque at $600\,rpm$, the armature current is $20\,A$. If the speed is raised to $800\,rpm$ by using flux control method, solve for the value of the resistance inserted. The magnetic circuit remains unsaturated for this setup. (09) (PO1) (CO1)

e) A 6–pole, $500\,V$ wave–connected shunt dc motor has 1200 armature conductors and a useful flux/pole of $20\,mWb$. The armature and field resistances are $0.5\,\Omega$ and $250\,\Omega$ repectively. Solve for: (09) (PO1) (CO1)

i) Speed and developed torque when the motor draws $20\,A$ from the supply mains. Neglect armature reaction.

ii) Useful torque, output in $kW$, and efficiency if magnetic and mechanical loss amount to $900\,W$.

2\. a) Evaluate the process of extracting the full–load saturation curve from the no–load saturation curve of a separately excited dc generator with relevant sketches. Compare the obtained characteristic curves with the internal and external characteristics curves of the same machine. Deduce the similarities and differences of these two characteristics curves. (15) (PO2) (CO2)

b) Compare the different characteristics curves of shunt, series, and compound motors. Summarize their electrical and mechanical characteristics in a "**Graph Paper**". Based on your findings, recommend the usage of different dc motors for practical/laboratory purposes with proper justification. (15) (PO2) (CO2)

c) Appraise the different speed control methods for a shunt dc motor. With necessary justifications, recommend the most preferred to least preferred method in terms of: (15) (PO2) (CO2)

i) Obtaining maximum speed compared to rated speed,
ii) Obtaining minimum speed compared to rated speed,
iii) Effect of armature reaction,
iv) Associated power loss due to the application of a speed control method, and
v) Cost of the system.

d) For the series–parallel speed control system of dc series motors depicted in Fig. 2(e), analyze the combined speed of the system for different combinations of A, B, C, and D and estimate the values of different speeds in a descending order with proper justifications. (15) (PO2) (CO2)

i) $N_1$ = Speed for $A = 100\ \Omega, B = 100\ \Omega, C = 100\ \Omega$, and $D = 100\ \Omega$,
ii) $N_2$ = Speed for $A = 110\ \Omega, B = 100\ \Omega, C = 110\ \Omega$, and $D = 100\ \Omega$,
iii) $N_3$ = Speed for $A = 100\ \Omega, B = 110\ \Omega, C = 100\ \Omega$, and $D = 110\ \Omega$,
iv) $N_4$ = Speed for $A = 90\ \Omega, B = 100\ \Omega, C = 90\ \Omega$, and $D = 100\ \Omega$, and
v) $N_5$ = Speed for $A = 100\ \Omega, B = 90\ \Omega, C = 100\ \Omega$, and $D = 90\ \Omega$.

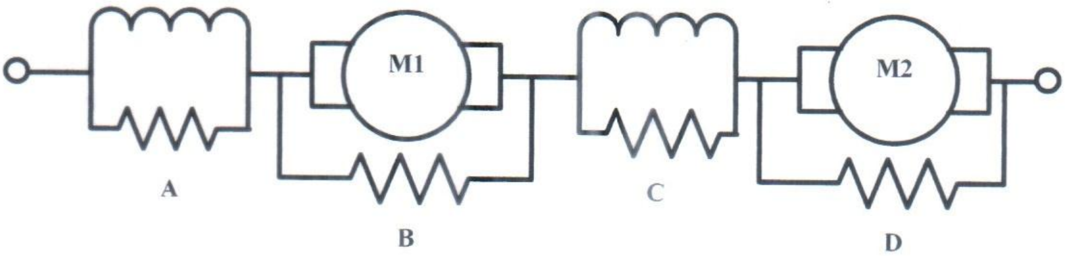


Fig. 2(e)

e) Evaluate the generator action of a simple dc machine and that of a dc shunt generator. Summarize the followings for both machines along with necessary diagrams: (15) (PO2) (CO2)

i) Nature of buildup of $e_{ind}$,
ii) Nature of rated speed, $v_{rated}$,
iii) The motor action inside the generator,
iv) Nature of the converted power, $P_{conv}$, and
v) Nature of current flow.

f) Compare the armature reaction and commutation for a 2–pole dc shunt generator. Determine and summarize the dependency or non–dependency of demagnetization and cross–magnetization on reactance voltage, sparking, and time of commutation with proper depiction of graphs and diagrams. (15) (PO2) (CO2)

g) Deduce the differences in the vector diagrams of a transformer having a resistance and leakage reactance with inductive and capacitive loads connected across secondary with proper sketches in terms of: (15) (PO2) (CO2)

i) Voltage and current on primary side and
ii) Voltage and current on secondary side.

B.Sc. in EEE, 3rd Semester

December 13, 2022
10:00 am – 01:00 pm

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

Semester Final Examination
Course No.: EEE 4307
Course Title: Digital Electronics

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) Assume an arbitrary number system having a base of *5* and *0, 1, 2, L* and *M* as its independent digits. Determine: **10 (CO2, PO2)**
   (i) The decimal equivalent of *(12LM. L1)*.
   (ii) The total number of possible three-digit combinations in this arbitrary number system.

   b) (i) Determine the value of base $x$ if $(211)_x = (152)_8$. **10 (CO2, PO2)**
   (ii) The 7's complement of a certain octal number is 5264. Determine the binary and hexadecimal equivalents of that octal number.

   c) Show that the dual of the exclusive-OR is equal to its complement. **5 (CO1, PO1)**

2. a) For the combinational logic shown in Figure 2.a, determine the outputs functions A and B as sums of minterms. You may use any process to determine the result, but show your process. **12 (CO2, PO2)**

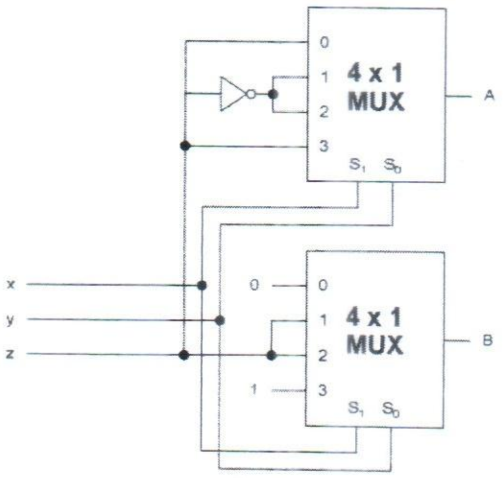


Figure 2.a

   b) Design a magnitude comparator circuit **using 4 to 16 line Decoder** for 2-bit binary numbers $A = A_1A_0$ and $B = B_1B_0$. The outputs are *F*, *G*, and *H*, where *F* is 1 if $A > B$, *G* is 1 if $A = B$, and *H* is 1 if $A < B$. (Internal diagram of Decoder is not needed) **13 (CO3, PO2)**

3. a) Derive the state table and the state diagram of the sequential circuit shown in Figure 3.a. **13 (CO2, PO1)**

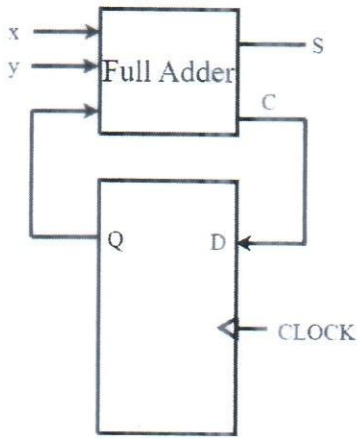


Figure 3.a

b) Suppose you are given a supply of a 25 KHz square wave signal. Design a circuit that will take the mentioned square wave signal as input and give **12.5 KHz signal with 25% duty cycle** as output . **12 (CO3, PO2)**

4. a) Show the logic diagram of a single bit memory cell using J-K flip flop. **8 (CO1, PO1)**

b) The following memory units are specified by the number of words times the number of bits per word. Calculate the number of address lines and input-output data lines that are needed in each case: **12 (CO2, PO2)**

i. 2 K × 16
ii. 64 K × 8
iii. 16 M × 32
iv. 96 K × 12

c) Calculate the number of 128K × 16 RAM chips needed to provide a memory capacity of 2MB. Show necessary calculations. **5 (CO2, PO2)**

5. a) Design a sequence detector that has a form shown in figure 5.a. The output $Z$ should be 1 if the input sequence ends in either 1000 or 0011 and $Z$ should be 0 otherwise. **12 (CO3, PO2)**

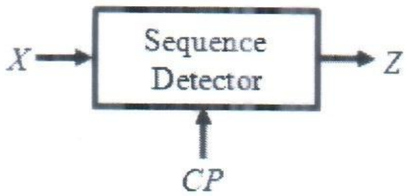


Figure 5.a

b) Apply the following logic expression in CMOS. **13 (CO2, PO2)**
F = A.B.C + B.(A + C)

6. a) Construct a J-K flip-flop with 'Preset' and 'Clear' inputs. Show the characteristic table. **10 (CO1, PO1)**

b) For the J-K flip-flops with inputs as shown in the Figure 6.b, sketch the time-line diagram for the $Q_0$ and $Q_1$ output relative to the clock pulse (CP). **15 (CO2, PO2)**

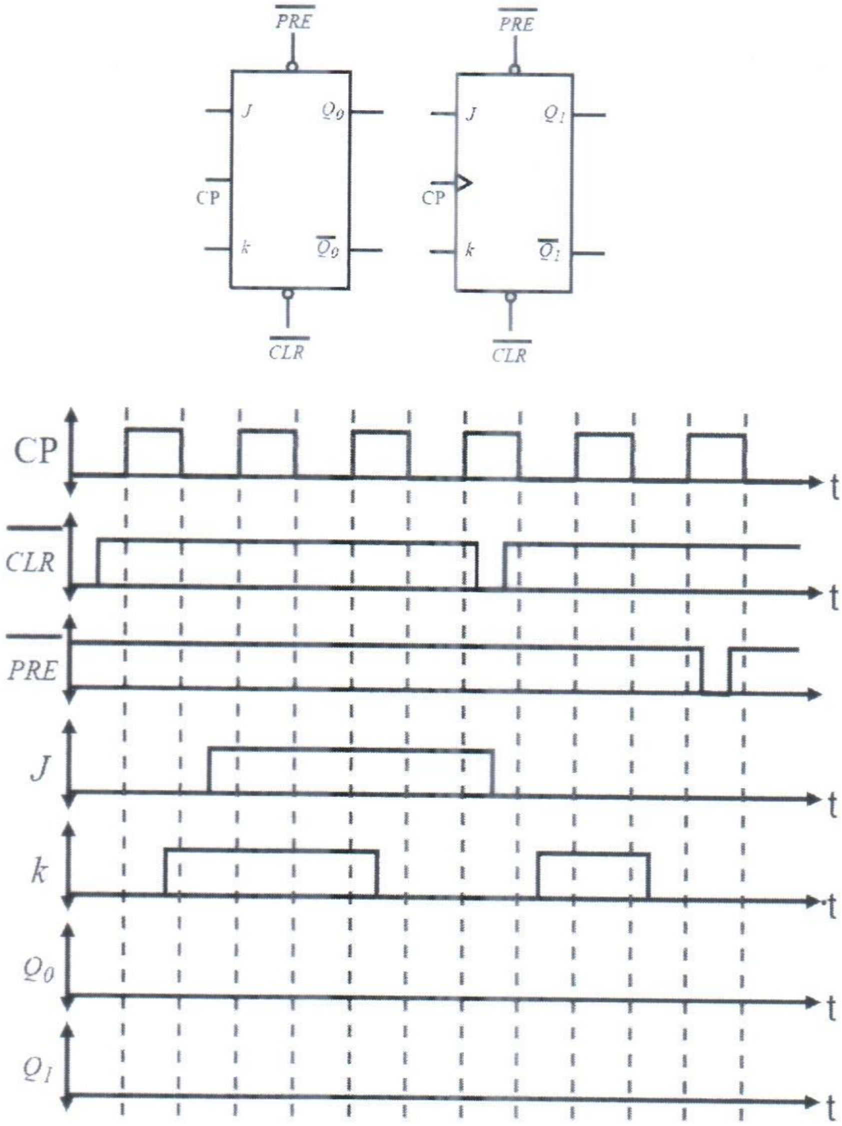


Figure 6.b

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B.Sc. in EEE, 3rd Semester/BSTE 1st Semester

December 15, 2022
10:00 am – 1:00 pm

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

## DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: Math 4321/Math 4529
Course Title: Transform Techniques And Linear Algebra

Winter Semester: 2021-2022
Time: 3 Hours
Full Marks: 150

There are **8 (Eight)** questions. Answer **any 6 (Six)** 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) Define Euclidean inner product of two vectors in $\Re^n$. Give an example of vectors in $\Re^4$. (5) CO1 PO1

(b) If $\mathbf{u}$ and $\mathbf{v}$ are in $\Re^n$ and $k$ is any scalar, then prove that (5+5) CO1 PO1

(i) $\|k\mathbf{u}\| = |k|\|\mathbf{u}\|$,

(ii) $\|\mathbf{u}+\mathbf{v}\| \le \|\mathbf{u}\| + \|\mathbf{v}\|$.

(c) (i) Find the standard matrix for the linear operator $T: \Re^3 \to \Re^3$ given by (5) CO2 PO2

$$w_1 = 3x_1 + 5x_2 - x_3$$
$$w_2 = 4x_1 - x_2 + x_3$$
$$w_3 = 3x_1 + 2x_2 - x_3.$$

(ii) Using matrix multiplication find the image of the vector $(-2,1,2)$ if it is rotated $30^0$ about the $x$-axis. (5)

2.(a) Define vector space with axioms. (5) CO1 PO1

(b) If $W$ is a set of one or more vectors from a vector space $V$, then prove that $W$ is a subspace of $V$ if and only if the following conditions hold: (10) CO2 PO2

(i) If $\mathbf{u}$ and $\mathbf{v}$ are vectors in $W$, then $\mathbf{u}+\mathbf{v}$ is in $W$.

(ii) If $k$ is any scalar and $\mathbf{u}$ is any vector in $W$, then $k\mathbf{u}$ is in $W$.

(c) Determine whether the set of all $2 \times 2$ matrices of the form $\begin{bmatrix} a & a+b \\ a+b & b \end{bmatrix}$ with matrix addition and scalar multiplication is vector space or not under the given operations. (10) CO2 PO2

3.(a) Define the spanning set of a vector space with an example. (5) CO1 PO1

(b) Consider the vectors $\mathbf{u} = (1,2,-1)$ and $\mathbf{v} = (6,4,2)$ in $\Re^3$. Show that $\mathbf{w} = (9,2,7)$ is a linear combination of $\mathbf{u}$ and $\mathbf{v}$ and $\mathbf{w}' = (4,-1,8)$ is not a linear combination of $\mathbf{u}$ and $\mathbf{v}$. (10) CO2 PO2

(c) Determine whether the vectors $\mathbf{v}_1 = (1,1,2)$, $\mathbf{v}_2 = (1,0,1)$ and $\mathbf{v}_3 = (2,1,3)$ span the vector space $\Re^3$ or not. (10) CO2 PO2

4.(a) Define the basis and dimension of a vector space. Write down the standard basis in $\Re^3$. (5) CO1 PO1

(b) Determine whether the vectors $\mathbf{v}_1 = (1,-2,3)$, $\mathbf{v}_2 = (5,6,-1)$ and $\mathbf{v}_3 = (3,2,1)$ form a linearly dependent set or a linearly independent set. (10) CO2 PO2

(c) Determine a basis and the dimension of the solution space of the homogeneous system (10) CO2 PO2

$$\begin{aligned} 2x_1 + 2x_2 - x_3 \qquad\quad + x_5 &= 0 \\ -x_1 - x_2 + 2x_3 - 3x_4 + x_5 &= 0 \\ x_1 + x_2 - 2x_3 \qquad\quad - x_5 &= 0 \\ x_3 + x_4 + x_5 &= 0. \end{aligned}$$

| | | | |
|---|---|---|---|
| 5.(a) | Define a real inner product space with example. Discuss norm and distance of two vectors $\boldsymbol{u}, \boldsymbol{v}$ with examples. | (5) | CO1 PO1 |
| (b) | Let $R^3$ have the Euclidean inner product. Use the Gram-Schmidt process to transform the basis $\{u_1, u_2, u_3\}$ where $u_1 = (1, 1, 1), u_2 = (-1, 1, 0), u_3 = (1, 2, 1)$. | (10) | CO2 PO2 |
| (c) | Find the QR-decomposition of the matrix given below $$\begin{bmatrix} 1 & 2 & 1 \\ 1 & 1 & 1 \\ 0 & 3 & 1 \end{bmatrix}.$$ | (10) | CO2 PO2 |

6.(a) Define diagonalizable of a matrix. (5) CO1 PO1

(b) Determine whether $A$ is diagonalizable. If so, find a matrix $P$ that diagonalizes $A$, and determine $P^{-1}AP$. (10) CO2 PO2

$$\begin{bmatrix} 5 & 0 & 0 \\ 1 & 5 & 0 \\ 0 & 1 & 5 \end{bmatrix}.$$

(c) Find the various currents in the circuit shown in Figure 1. (10) CO2 PO2

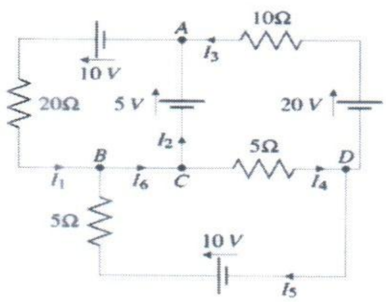


**Figure 1**

7.(a) Define Laplace transforms. Find the inverse Laplace transforms of (5) CO2 PO2

$$\frac{1}{s^2 - 5s + 6}.$$

(b) Using the Laplace transforms, find the solution to the initial value problem: $y'' - 4y' + 4y = 64 \sin 2t,\ y(0) = 0,\ y'(0) = 1.$ (10) CO3 PO2

(c) Using Laplace transform, find the current $i(t)$ in the $LC$-circuit shown in Figure 2. Assuming $L = 1$ henry, $C = 1$ farad, zero initial current and charge on the capacitor, and (10) CO3 PO2

$$v(t) = t \quad \text{when } 0 < t < 1,$$
$$= 0 \quad \text{otherwise.}$$

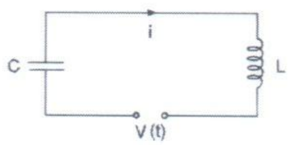


**Figure 2**

8.(a) Define even and odd functions. Give examples of even and odd functions with graphical representation. (5) CO1 PO1

(b) Find the Fourier series expansion of the periodic function of the period $2\pi$ for $f(x) = x^2$ for $-\pi \le x \le \pi$. (10) CO3 PO2

Hence find the sum of the series $\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \dots\dots$

(c) The displacement $f(x)$ of a part of a machine is tabulated with the corresponding angular moment "$x$" of the crank. Find a Fourier series to represent $f(x)$ for all values of $x$ up to third harmonic. (10) CO3 PO2

| $x$ | $0^0$ | $30^0$ | $60^0$ | $90^0$ | $120^0$ | $150^0$ | $180^0$ | $210^0$ | $240^0$ | $270^0$ | $300^0$ | $330^0$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $f(x)$ | 1.80 | 1.10 | 0.30 | 0.16 | 0.50 | 1.30 | 2.16 | 1.25 | 1.30 | 1.52 | 1.76 | 2.00 |

B.Sc. Engg. (ME/IPE), 3rd Semester

December 12, 2022 (Morning)
10:00 am – 1:00 pm

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

Semester Final Examination
Course No.: EEE 4381
Course Title: Electronics and Digitization Techniques

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) Determine $V_1$ and $V_2$ from the circuits in Fig. 1(a) and 1(b). **10 (CO2, PO2)**

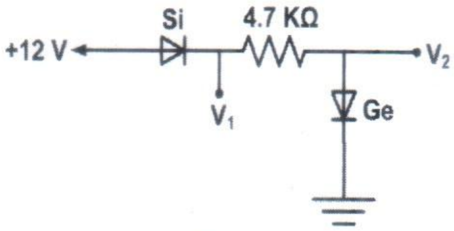


Fig. 1(a)

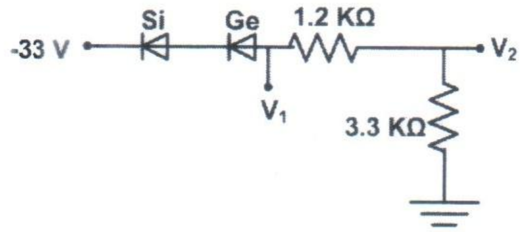


Fig. 1(b)

b) For the zener diode network of Fig. 1(c), (i) determine $V_L$, $V_R$, $I_Z$ and $P_Z$ considering $V_Z = 12$ V and $P_{ZM} = 40$ mW. (ii) Repeat part (i) with $R_L = 15$ kΩ. **15 (CO2, PO2)**

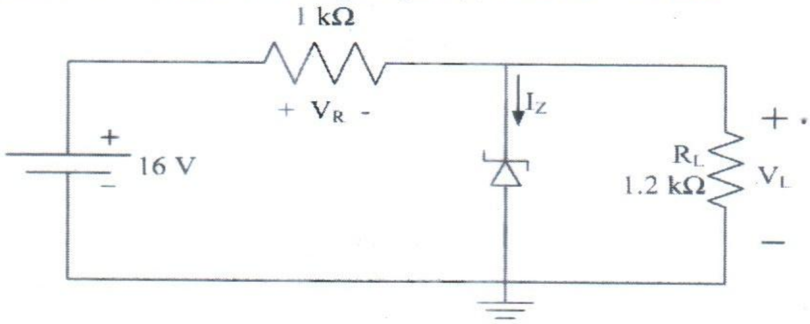


Fig. 1(c)

2. a) Sketch the output voltage $V_o$ for the network of Fig. 2(a) and 2(b) considering silicon diode. Reanalyze the circuit of Fig. 2(b) considering silicon diode with threshold voltage, $V_T = 0.75$ V. $V_i$ (peak-peak) = 20 V, V = 5 V, C = 1 μF and R = 1000 Ω. Show necessary calculations. **16 (CO2, PO2)**

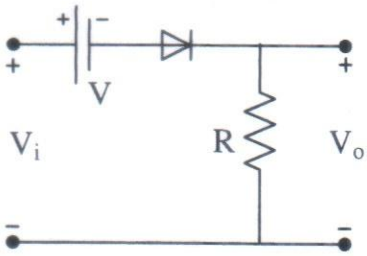


Fig. 2(a)

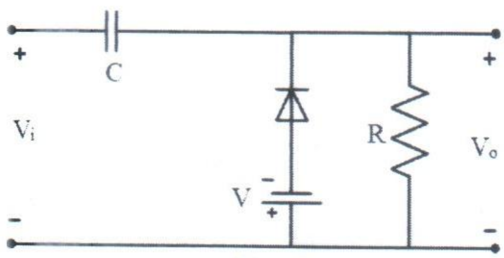


Fig. 2(b)

b) Identify the biasing condition of two junctions for each mode of operation of a Bipolar Junction Transistor (BJT). **09 (CO1, PO1)**

3. a) A digital switch turns "ON" for 5 V and turns "OFF" for 0 V at its input terminal. The switch needs to be replaced by a transistor. Choose the type of transistor (BJT/JFET/MOSFET) you would use to replace the switch with justification. **08 (CO3, PO2)**

b) Determine the dc bias voltage $V_{CE}$, collector current $I_C$, base voltage $V_B$ and output voltage $V_o$ for the configuration of Fig. 3(b). Consider $\beta = 90$. **08 (CO2, PO2)**

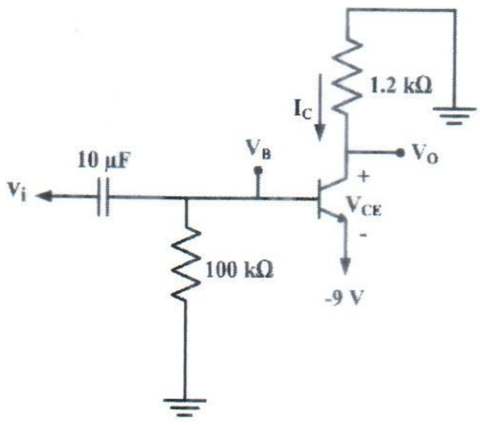


Fig. 3(b)

c) Sketch the transfer curve of a JFET with $V_P = -6$ V and $I_{DSS} = 10$ mA, using Shockley's equation (For exactly 06 values of $V_{GS}$). Repeat the problem using Shorthand method. **09 (CO1, PO1)**

4. a) A JFET has a pinch off voltage = - 8 V and $I_{DSS} = 12$ mA. The resistance of the JFET is 1KΩ with gate and source short circuited. Apply proper operating condition(s) to use this JFET as a resistor of 1.5 KΩ. **09 (CO3, PO2)**

b) Differentiate between the construction of an enhancement-type MOSFET and a depletion-type MOSFET. Discuss the possibility of a depletion-type MOSFET being operated in the enhancement mode and vice versa. **08 (CO1, PO1)**

c) Describe the process of reduction in free carriers in the channel due to negative potential at the gate terminal of an n-channel depletion type MOSFET. **08 (CO1, PO1)**

5. a) Define an op-amp and mention the pin configuration of LM-741 op-amp IC. **05 (CO1, PO1)**

b) Formulate the following equation using op-amps: **10 (CO3, PO2)**

$$9x_1 - 7x_2 - 3\frac{dy}{dt} + 6\int x_3\,dt + 5\frac{dx_4}{dt} = 0$$

where $x_1$, $x_2$, $x_3$ and $x_4$ are the inputs and $y$ is the output.

c) Design an astable multivibrator to produce a positive cycle of 3 ms and a negative cycle of 2 ms at the output. Show necessary calculations and sketch the output and capacitor voltage waveshapes. **10 (CO3, PO2)**

6. a) Describe the differences between analog and digital signals using appropriate example. **4 (CO1, PO1)**

b) Design an 8-bit to 3-bit priority encoder (LSB has the highest priority) using digital logic gates. Formulate the truth table. Derive the expressions and implement them using logic gates. **11 (CO3, PO2)**

c) Design a 4-bit R/2R Ladder Digital to Analog converter and find the output voltage for inputs 0110 and 1010. **10 (CO3, PO2)**

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B.Sc. in CSE, 3rd Semester

December 15, 2022
10:00 am – 1:00 pm

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

Semester Final Examination
Course No.: EEE 4383
Course Title: Electronic Devices and Circuits

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) Write down the three most important characteristics of an ideal operational amplifier. **06 (CO1, PO1)**

   b) Calculate $V_0$ and $i_0$ in the Op-amp circuit of fig. 1(b). **10 (CO3, PO3)**

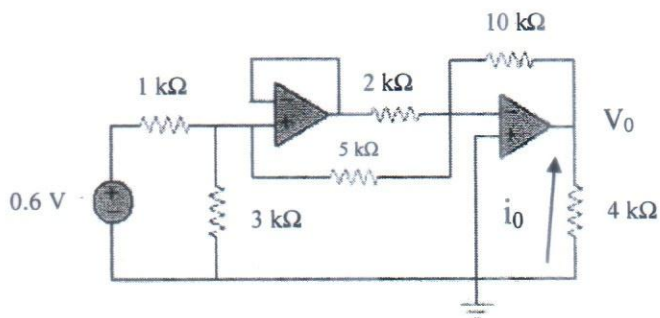


Fig. 1(b)

   c) Using the ideal Op-amp, design a circuit that will take $V_1$, $V_2$ & $V_3$ as inputs and will produce the following output: **09 (CO3, PO3)**

$$V_{out} = 5V_1 - 10\, dV_2/dt + 2 \int V_3\, dt$$

2. a) Write down the significant difference between the construction of an enhancement type MOSFET and a depletion type MOSFET. **04 (CO1, PO1)**

   b) Sketch an n-channel enhancement-type MOSFET with the proper biasing applied ($V_{DS}$>0 V, $V_{GS}$> $V_T$) and indicate the channel, the direction of electron flow, and the resulting depletion region. Briefly describe the basic operation of an enhancement-type MOSFET. **15 (CO1, PO1)**

   c) Sketch the transfer characteristics for an n-channel depletion-type MOSFET with $I_{DSS}$=10 mA and $V_P$= - 4V. **06 (CO1, PO1)**

3. a) Write down at least five applications of UJT. **05 (CO1, PO1)**

   b) Sketch UJT static emitter characteristic curve with proper labeling and explain its three operating regions. **12 (CO1, PO1)**

c) For a unijunction transistor with $V_{BB}$= 20V, $\eta$=0.65, $R_{B1}$= 2kΩ ($I_E$=0), and $V_D$ = 0.7 V, determine: **08 (CO3, PO3)**

   i. $R_{B2}$
   ii. $R_{BB}$
   iii. $V_{RB1}$
   iv. $V_P$

4. a) Write down at least five major differences between the Bipolar junction transistor (BJT) and Field effect transistor (FET). **05 (CO1, PO1)**

   b) Design a CMOS inverter using a P-channel MOSFET and an N-channel MOSFET and explain how CMOS works as an inverter. **10 (CO3, PO3)**

   c) Illustrate the basic construction of a P-channel JFET. For $V_{GS}$= 0V, briefly describe the working principle of P-channel JFET. Apply the proper biasing between drain and source and sketch the drain characteristics curve for different values of $V_{GS}$. **10 (CO2, PO2)**

5. a) Sketch the effect of an increasing level of $R_c$ on the load line and the Q point in the output characteristics curve of BJT. **05 (CO1, PO1)**

   b) Explain three types of equivalent circuits of a diode and sketch their corresponding characteristics. **06 (CO1, PO1)**

   c) Analyze the circuit using small signal $r_e$ model of fig. 5(c) and find the following parameters. **14 (CO2, PO2)**

   i. Calculate $I_B$, $I_C$, and $r_e$.
   ii. Determine $Z_i$ and $Z_o$.
   iii. Calculate $A_v$.
   iv. Determine the effect of $r_o$ = 30 kΩ on $A_v$.

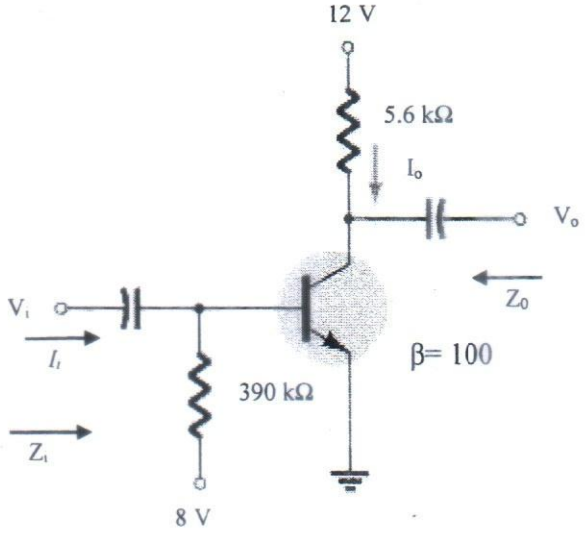


Fig. 5(c)

6. a) Sketch the output voltage wave shape ($V_O$) of fig. 6(a) and show the necessary calculation. **05 (CO1, PO1)**

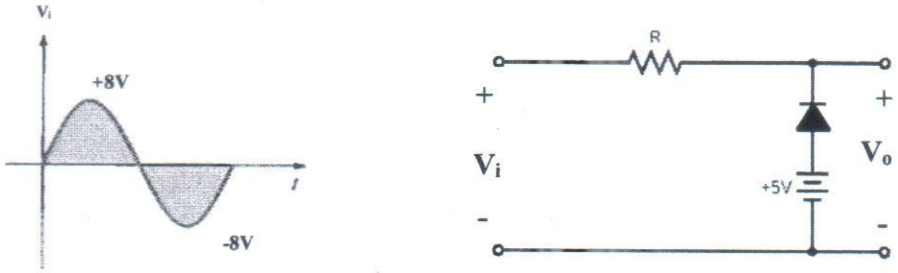


Fig. 6(a)

b) Write down the different modes of operation of BJT and the working principle of BJT for common emitter configuration. **10 (CO1, PO1)**

c) For the emitter-bias network of fig. 6(c), determine **10 (CO2, PO2)**

i. $I_B$
ii. $I_C$
iii. $V_{CE}$
iv. $V_C$
v. $V_E$
vi. $V_B$
vii. $V_{BC}$

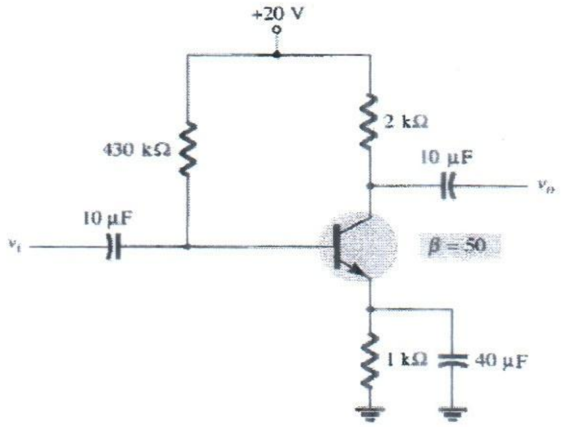


Fig. 6(c)

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B.Sc. in CEE, 3rd Semester

December 13, 2022
10:00 am – 1:00 pm

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

Semester Final Examination
Course No.: EEE 4385
Course Title: Electrical and Electronic Technology

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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 circuit shown in Figure 1(b) has been obtained from the circuit shown in Figure 1(a) by replacing series and parallel combinations of resistances by equivalent resistances. **15 (CO1, PO2)**

   i. Determine the values of the resistances $R_1$, $R_2$, and $R_3$ in Figure 1(b) so that the circuit shown in Figure 1(b) is equivalent to the circuit shown in Figure 1(a).

   ii. Determine the values of $v_1$, $v_2$, and $i$ in Figure 1(b).

   iii. Because the circuits are equivalent, the values of $v_1$, $v_2$, and $i$ in Figure 1(a) are equal to the values of $v_1$, $v_2$, and $i$ in Figure 1(b). Determine the values of $v_4$, $i_5$, $i_6$and $v_7$ in Figure 1(a).

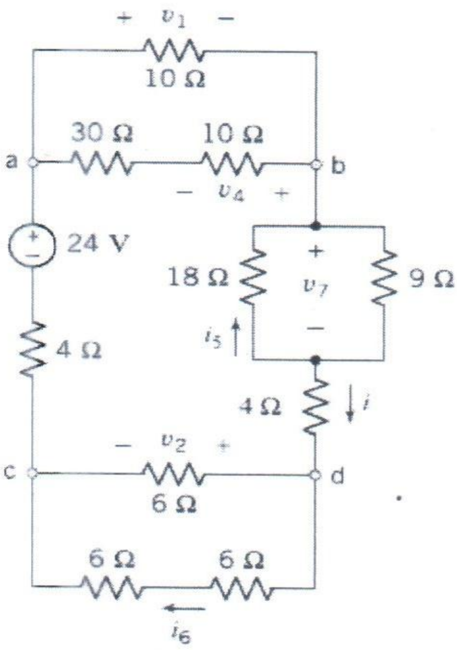


**Figure 1(a)**

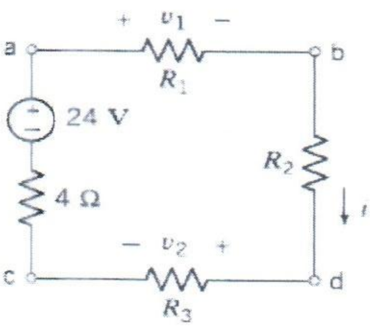


**Figure 1 (b)**

b) Define the term Power Factor Correction. Explain the methods of Power Factor correction. **10 (CO2, PO1)**

For a DC electrical network, show that $R_L = R_{th}$ and $P_{max} = \frac{V_{th}^2}{4R_{th}}$.

Where, $R_L$= load resistance
$R_{th}$= thevenin resistance
$V_{th}$= thevenin voltage
$P_{max}$= maximum power transfer

2. a) Determine values of the node voltages $v_1$, $v_2$, $v_3$, $v_4$, and $v_5$ in the circuit shown in Figure 2(a). **15 (CO2, PO2)**

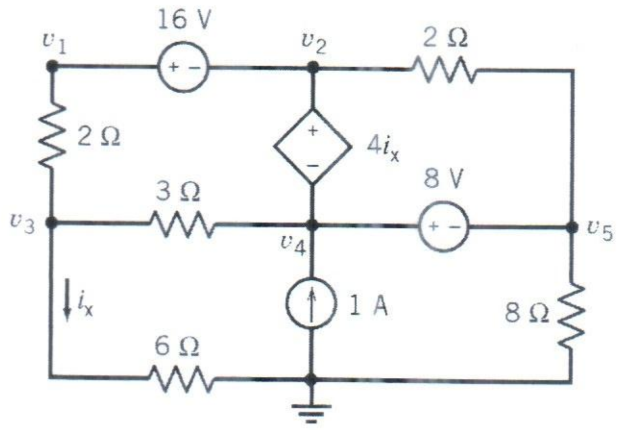


**Figure 2(a)**

b) For the circuit in Figure 2(b), determine the value of R and $R_L$ such that the maximum power delivered to the load is 3 mW. **10 (CO2, PO2)**

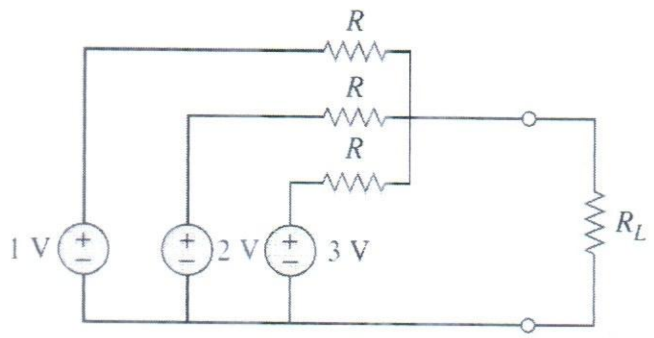


**Figure 2(b)**

3. a) An induction coil in a bulb induces a high-frequency energy flow in mercury vapor to produce light. The lamp uses about the same amount of energy as a fluorescent bulb but lasts six times longer, with 60 times the life of a conventional incandescent bulb. The circuit model of the bulb and its associated circuit are shown in Figure 3(a). Determine the value of L. **10 (CO1, PO1)**

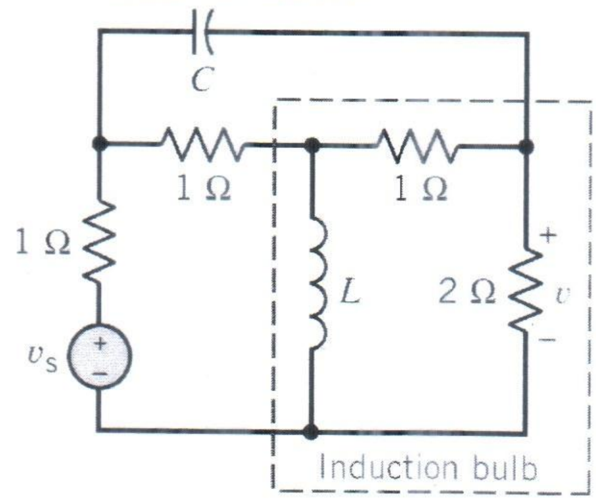


Figure 3(a)

Where, $C = 40\ \mu F$, $\omega_0 = 10^5$ rad/s,

$$v_s(t) = 10\cos(\omega_0 t + 30^0)\ V$$

$$v(t) = 6.45\cos(\omega_0 t + 44^0)\ V$$

b) The load resistance $R_L$, in Figure 3(b), is adjusted until it absorbs the maximum average power. Calculate the value of $R_L$ and the maximum average power. **15 (CO2, PO2)**

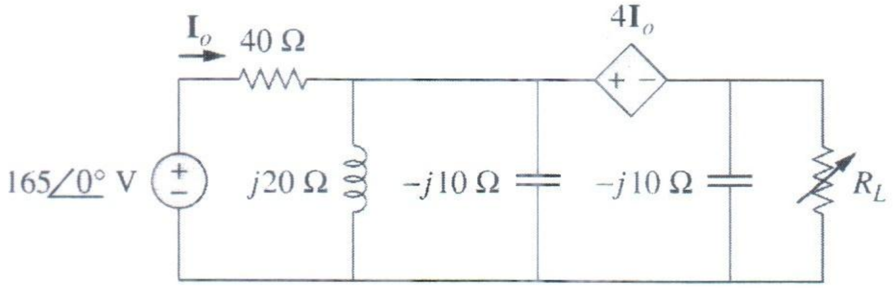


Figure 3(b)

4. a) Write down the advantages of electric braking over traditional braking. Write down different methods of speed control for DC shunt motor. **10 (CO3, PO1)**

   b) In a 120 V compound generator, the resistances of the armature, shunt and series windings are 0.06 Ω, 25 Ω and 0.04 Ω, respectively. The load current is 100 A at 120 V. Find the induced e.m.f. and the armature current when the machine is connected as **15 (CO3, PO2)**

   i. long-shunt generator
   ii. short-shunt generator
   iii. if a diverter of 0.1 Ω is connected in parallel with the series winding.

   Consider 2-V brush contact drop but ignore armature reaction. Draw proper diagram for each case.

5. a) Sketch the power stage diagram for a DC motor. Find the condition for maximum power of a DC motor. **10 (CO3, PO1)**

   b) A 6 pole, 240 V, wave connected shunt motor gives 1119 kW when running at 1200 r.p.m. and drawing armature and field currents of 50 A and 1.5 A respectively. It has 540 conductors. Its resistance is 0.1 Ω. Assuming a drop of 1.0 V per brush, find, **15 (CO3, PO2)**

   i. total torque
   ii. useful torque
   iii. useful flux/pole
   iv. rotational losses
   v. efficiency

6. a) Briefly describe the AC power generation, transmission and distribution system of a country. **7 (CO3, PO1)**

   b) Sketch the equivalent circuit diagram of a transformer. Identify why the transformer rating is in KVA. **5 (CO3, PO1)**

   c) Define the parallel operation of alternators. Discuss the conditions that need to be satisfied for proper synchronization of alternators. **5 (CO3, PO1)**

   d) Write down the classification of different types of power electronics rectifier circuit with proper diagram. Distinguish between IPS and UPS. **8 (CO4, PO1)**

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B.Sc. Engg. (EE), 5th Semester

November 30, 2022

10:00 AM – 1:00 PM

**ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)**

ORGANISATION OF ISLAMIC COOPERATION (OIC)

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

Semester Final Examination
Course No.: EEE 4501
Course Title: Electromagnetic Fields and Waves

Winter Semester, A.Y. 2021-2022
Full Marks: 150
Time: 3 Hours

There are **06 (six)** questions. Answer all **06 (six)** 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.

---

**1. a)** Let $\mathbf{D} = 2xy\,\mathbf{a}_x + x^2\,\mathbf{a}_y$ C/m$^2$. Find: **(5+5+5) (CO3) (PO2)**

i) the volume charge density $\rho_v$ ,

ii) the flux through surface $0 < x < 1, 0 < z < 1, y = 1$ and

iii) the total charge contained in the region $0 < x < 1, 0 < y < 1, 0 < z < 1$.

**b)** i) The region between concentric spherical conducting shells $r = 0.5$ m and $r = 1$ m is charge free. If $V(r = 0.5) = -50$ V and $V(r = 1) = 50$ V, determine the potential distribution in the region between the shells. **(10+5) (CO3) (PO2)**

ii) In free space, infinite planes $y = 4$ and $y = 8$ carry charges 20 nC/m$^2$ and 30 nC/m$^2$, respectively. If plane $y = 2$ is grounded, calculate **E** at $P(-4, 6, 2)$.

**2. a)** An infinitely long cylindrical conductor of radius $a$ is placed along the $z$-axis. If the current density is $\mathbf{J} = (J_o / \rho)\,\mathbf{a}_z$ ,where $J_o$ is constant, find **H** at $0 < \rho < a$ and $\rho > a$. **(10+5) (CO3) (PO2)**

**b)** In a magnetic material, with $\chi_m = 6.5$, the magnetization is $\mathbf{M} = 24y^2\mathbf{a}_z$ A/m. Find $\mu_r$, **H**, and **J** at $y = 2$ cm. **(5+5+5) (CO3) (PO2)**

**3. a)** A current sheet with $\mathbf{K} = 12\mathbf{a}_y$ A/m is placed at $x = 0$, which separates region 1, $x < 0$, $\mu = 2\mu_o$ and region 2, $x > 0$, $\mu = 4\mu_o$. If $\mathbf{H}_1 = 10\mathbf{a}_x + 6\mathbf{a}_z$ A/m, find $\mathbf{H}_2$. **(15) (CO3) (PO2)**

**b)** State and explain Lenz's law using suitable diagram. Using Faraday's Law, deduce the equations of electromotive force in case of a stationary loop in a time varying magnetic field and a moving loop in a static magnetic field. **(5+5+5) (CO4) (PO2)**

**4. a)** i) In a certain region, $\mathbf{J} = (\,2y\,\mathbf{a}_x + xz\,\mathbf{a}_y + z^3\,\mathbf{a}_z\,)\sin 10^4 t$ A/m$^2$. Determine $\rho_v$ if $\rho_v(x, y, 0, t) = 0$. **(5+5+5) (CO4) (PO2)**

ii) In a source-free region, $\mathbf{H} = H_o\cos(\omega t - \beta z)\mathbf{a}_x$ A/m. Determine the displacement current density.

iii) In free space, the retarded potentials are given by $V = x(z - ct)$ V, $\mathbf{A} = x(z/c - t)\mathbf{a}_z$ Wb/m. Determine **E**.

**b)** In a source-free vacuum region, **(15) (CO4) (PO2)**

$$\mathrm{H} = \frac{1}{\rho}\cos(\omega t - 3z)\mathbf{a}_\phi \ \mathrm{A/m}.$$

Using phasor algebra, find associated **E** field and $\omega$.

5. a) Explain, using the appropriate parameters, what you understand by lossy dielectric, lossless dielectric and good conductor in case of electromagnetic wave propagation. **(3+3+3) (CO5) (PO2)**

   b) Define complex permittivity of a medium and state how it is related to the loss tangent of that medium. Write time-harmonic (phasor) Maxwell's equations in differential/point form. **(2+4) (CO5) (PO2)**

6. a) A certain medium has $\sigma = 1$ S/m, $\varepsilon = 4\varepsilon_0$ and $\mu = 9\mu_0$ at a frequency of 1 GHz. Determine the attenuation constant, phase constant, intrinsic impedance and wave velocity. **(4×3) (CO5) (PO2)**

   b) For silver, $\sigma = 6.1\times10^7$ S/m, $\mu = \mu_0$, $\varepsilon = \varepsilon_0$. Determine the frequency of the EM wave at which the penetration depth is 2 mm. **(3) (CO5) (PO2)**

# VECTOR DERIVATIVES

**Cartesian Coordinates** $(x, y, z)$

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

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

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

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

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

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

**Cylindrical Coordinates** $(\rho, \phi, z)$

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

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

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

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

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

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

**Spherical Coordinates** $(r, \theta, \phi)$

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

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

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

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

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

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

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

Relationships between Rectangular, Cylindrical, and Spherical Coordinates

**Rectangular to Cylindrical**

Variable change
$$\begin{cases} x = \rho\cos\phi \\ y = \rho\sin\phi \\ z = z \end{cases}$$

Component change
$$\begin{cases} A_\rho = A_x\cos\phi + A_y\sin\phi \\ A_\phi = -A_x\sin\phi + A_y\cos\phi \\ A_z = A_z \end{cases}$$

**Cylindrical to Rectangular**

Variable change
$$\begin{cases} \rho = \sqrt{x^2+y^2} \\ \phi = \tan^{-1}\left(\dfrac{y}{x}\right) \begin{cases} \sin\phi = \dfrac{y}{\sqrt{x^2+y^2}} \\ \cos\phi = \dfrac{x}{\sqrt{x^2+y^2}} \end{cases} \\ z = z \end{cases}$$

Component change
$$\begin{cases} A_x = A_\rho\dfrac{x}{\sqrt{x^2+y^2}} - A_\phi\dfrac{y}{\sqrt{x^2+y^2}} \\ A_y = A_\rho\dfrac{y}{\sqrt{x^2+y^2}} + A_\phi\dfrac{x}{\sqrt{x^2+y^2}} \\ A_z = A_z \end{cases}$$

**Rectangular to Spherical**

Variable change
$$\begin{cases} x = r\sin\theta\cos\phi \\ y = r\sin\theta\sin\phi \\ z = r\cos\theta \end{cases}$$

Component change
$$\begin{cases} A_r = A_x\sin\theta\cos\phi + A_y\sin\theta\sin\phi + A_z\cos\theta \\ A_\theta = A_x\cos\theta\cos\phi + A_y\cos\theta\sin\phi - A_z\sin\theta \\ A_\phi = -A_x\sin\phi + A_y\cos\phi \end{cases}$$

**Spherical to Rectangular**

Variable change
$$\begin{cases} r = \sqrt{x^2+y^2+z^2} \\ \theta = \cos^{-1}\dfrac{z}{\sqrt{x^2+y^2+z^2}} \begin{cases} \cos\theta = \dfrac{z}{\sqrt{x^2+y^2+z^2}} \\ \sin\theta = \dfrac{\sqrt{x^2+y^2}}{\sqrt{x^2+y^2+z^2}} \end{cases} \\ \phi = \tan^{-1}\left(\dfrac{y}{x}\right) \begin{cases} \cos\phi = \dfrac{x}{\sqrt{x^2+y^2}} \\ \sin\phi = \dfrac{y}{\sqrt{x^2+y^2}} \end{cases} \end{cases}$$

Component change
$$\begin{cases} A_x = \dfrac{A_r x}{\sqrt{x^2+y^2+z^2}} + \dfrac{A_\theta xz}{\sqrt{(x^2+y^2)(x^2+y^2+z^2)}} - \dfrac{A_\phi y}{\sqrt{x^2+y^2}} \\ A_y = \dfrac{A_r y}{\sqrt{x^2+y^2+z^2}} + \dfrac{A_\theta yz}{\sqrt{(x^2+y^2)(x^2+y^2+z^2)}} + \dfrac{A_\phi x}{\sqrt{x^2+y^2}} \\ A_z = \dfrac{A_r z}{\sqrt{x^2+y^2+z^2}} - \dfrac{A_\theta\sqrt{x^2+y^2}}{\sqrt{x^2+y^2+z^2}} \end{cases}$$

(187)

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

Date: December 06, 2022
Time: 10 AM 1:00 PM

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

Semester Final Examination
Course No.: EEE 4503/EEE4591
Course Title: Power Electronics

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

**There are 6 (six) questions. Answer all 6 (six) questions. Note that question no.4 and question no. 6 have options.**

Marks in the margin indicate full marks. Do not write on this question paper. Assume reasonable value for any missing data. Marks of each question and corresponding COs and POs are in brackets.

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1. a) Define a power electronic system with the proper block diagram. Briefly state that in what basis a controller generates switching signal for the power processor in the system. 08 (CO1, PO1)

   b) Distinguish between the dc output voltages of an uncontrolled single phase bridge rectifier with and without source inductances for the highly inductive load. For both cases formulate the expression of output voltages sketching the circuit diagrams with waveshapes of necessary responses if a sinusoidal input is applied. 08 (CO2, PO2)

   c) The input voltage of the following converter is 230 V (rms), 50 Hz. The load current is 10 A continuous. If the power supplied to the load is 1.5 kW, (i) determine the firing angles for $T_1$ and $T_2$., (ii) sketch the waveshapes of $i_s$ and $V_o$. (iii) Compare output voltage waveshapes if $D_m$ is removed with if $D_m$ is there. 09 (CO2, PO2)

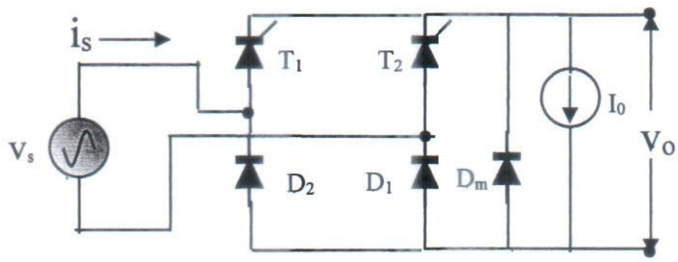


Fig. Q. 1(c)

2. a) Discuss on the advantages of a multi-phase rectifier over a single phase rectifier. Depict a multi-phase star rectifiers and find the expression of the dc output voltage. Explain how the frequency of the instantaneous output voltage can be increased. 08 (CO1, PO1)

   b) Depict the circuit diagram of a three bridge rectifier and the line to line voltages. Identify the devices operating in various portion of the voltages. Formulate the dc and rms value of the output voltages. 08 (CO1, PO1)

   c) A three phase bridge rectifier is supplying a purely resistive load. Find (i) the efficiency (ii) the FF , (iii) The RF (iv) PIV of each diode in terms of peak value of phase voltage $V_m$ 09 (CO2 PO2)

3. a) (i) Identify the main problems of using two thyristors for a bidirectional ac controller. 08 (CO2, PO2)
   (ii) Depict a circuit to overcome this problem.
   (iii) If the supply voltage of an ac controller is 220 V (rms) 50 Hz, find the firing angle of your thyristors/thyristor to have 100 V (rms) output voltage for a resistive load?

b) A single-phase full-wave ac controller with an R-L load is supplied with an rms voltage $V_S$=120 V, f=60 Hz. The load inductance is L=6.5 mH. The thyristors are fired at $\alpha_1 = 60^0$ and $\alpha_2 = \pi + 60^o$, respectively. The thyristor 1 ceases conduction at $\beta = 240^0$. 09 (CO2, PO2)
 (i) Find the value of load resistance.
 (ii) For this load, if $\alpha_1$ is made less than $60^0$, sketch the output voltage of the controller.

c) An ac controller has a resistive load of R=10 Ω and the input is 220 V, 50 Hz. The thyristors switch is on for n=25 cycles and for m=75 cycles. Determine 08 (CO2, PO2)
 (i) the rms value of the output voltage,
 (ii) the input power factor,
 (iii) the average and rms current through thyristors.

4. a) Draw the circuit diagram of a step down dc to dc converter with RL load. Suppose the converter is operating in the discontnuous mode. Define the time interval of the converter after the switch is off with proper expression. 13 (CO1, PO1)

b) A step-down converter is feeding an RL load with $V_S$=220 V, R=5 Ohm and L=7.5 mH, f=1 KHz, k=0.5. Find (i) the minimum and maximum values of instantaneous load current (ii) maximum peak to peak load ripple current (iii) the average value of the load current. 12 (CO2, PO2)

**OR**

4. a) Sketch the circuit diagram of a buck regulator. Drawing the wave-shapes of various branch currents clearly identify which current accounts for the ripple of the output voltage. Find the expressions of the ripple inductor current and ripple voltage at the output. 13 (CO1, PO1)

b) The buck regulator has an input voltage 15 V. The required average output voltage is 5 V. and peak to peak output voltage is 10 mV. The switching frequency is 20 kHz. The peak to peak inductor current ripple is 0.5 A. Find (i) duty cycle (ii) the filter inductance (iii) the filter capacitance and (iv) the critical inductance and capacitance. 12 (CO2, PO2)

5. a) (i) The CU'K converter has a distinct feature that makes it superior over the conventional buck-boost converter. Explain the feature. (ii) Depicting the circuit diagram of the CU'K converter, describe the operating principle for ON and OFF modes of power switch. (iii) Equating the volt-radian of inductors, find the expression of output voltage. 12 (CO1, PO1)

b) In a CU'K converter operating at 50 kHz, $L_1$=$L_2$=1 mH and $C_1$=5 μF. The output capacitance is sufficiently large to yield an essentially constant output voltage. Here $V_d$= 10 V and the output $V_o$ is regulated to be constant at 5 V. It is supplying 5 W to a load. Assume ideal components. Discuss on the percentage errors in assuming constant voltage across $C_1$ or in assuming constant currents $i_{L1}$ and $i_{L2}$. 13 (CO2, PO2)

6. a) Write the circuit operation of a single-phase full-bridge inverter. Sketch the wave-shapes of output voltage and current for an inductive load. Identfy the swiching states in a table of the above inverter to obtain an ac voltage. 12 (CO1, PO1)

b) A single phase full bridge inverter is supplying a resistive load of 10 Ω and its input is taken from an uncontrolled bridge rectifier where a transformer has been used whose secondary voltage is 53.5 V (RMS). Find (i) the rms output voltage at the fundamental frequency $V_{o1}$, (ii) the output power $P_o$ (iii) the average and peak currents of each transistor and (iv) the THD. 13 (CO2, PO2)

**OR**

6 a) (i) Describe the working priciple of induction heating. Write some of the industrial applications of induction heating 12 (CO1, PO1)
 (ii) Identifythe main differences beween IPS and UPS

b) For a three phase 50 Hz inverter, sketch the gating signals for 180 degree or 120 degree conduction and find the expressions of line to line voltage. If a Y load of R=10 ohm, and L= 10 mH per phase is connected to this inverter, calculate the line currents. 13 (CO2, PO2)

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B.Sc. in EEE, 5th Semester
B.Sc.TE (2-Yr), 1st Semester

December 12, 2022
10:00 am – 1.00 pm

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

Semester Final Examination
Course No.: EEE 4521/ EEE 4797
Course Title: Power System Protection I

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **5 (five)** questions. Answer all **5 (five)** 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. In Figure 1, consider a typical 3 phase power system which is composed of one generator on the generating side connected with two motors on the load side. Two transformers are connected in between the generation and load side for step up and step-down purpose. For each of the equipment in a power system there exist different protective systems as a result of which there exist no dead zone in this typical power system. The information about different equipment is given below:

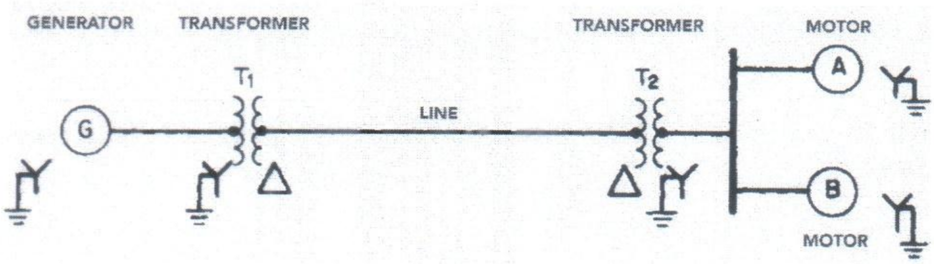


Figure 1

(i) Transformer 1: A large oil immersed 11 kV/132 kV transformer with primary side star connected and secondary side delta connected.
(ii) Transformer 2: A step down transformer 132 kV/ 33 kV, with primary side delta connected and secondary side star connected
(iii) Motor A and Motor B: 3 phase induction motor is connected
(iv) Generator: A 11 kV (line voltage) 3 phase star connected generator is present

a) Suppose someone mistakenly touched live terminal of the motor and gets a shock and is injured. Determine the measures or protection methods that should be followed to ensure no one gets a shock if he/she touches the live terminal by mistake. Illustrate it in details with necessary diagrams. **15 (CO2, PO2)**

b) Illustrate in details with necessary diagrams the protection schemes that you will adopt to protect Transformer 1 from internal faults. Illustrate the advantages and disadvantages of the protection schemes you will be adopting. **15 (CO2, PO2)**

c) Explain the protection scheme that you will adopt for Transformer 2 to protect it from differential fault. Justify your answer with proper diagram. Explain precautions and important points that should be followed to use such protection scheme. **10 (CO3, PO2)**

d) The generator is connected to a circuit breaker. The inductive reactance up-to the circuit breaker is 5 Ω/phase. The distributed capacitance up-to circuit breaker between phase and neutral is 0.0001 μF. Determine peak restriking voltage across the CB, frequency of restriking voltage transients, average rate of restriking voltage up-to peak restriking voltage, and maximum RRRV. **10 (CO1, PO1)**

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2. a) Define rate of rise of transient recovery voltage (TRV). Describe the effects of natural frequency and power factor on TRV with proper diagram. Determine the equation: **10 (CO1, PO1)**

$$R.R.R.V_{max} = 2\pi E_m f_n$$

where $E_m$ and $f_n$ have their usual meaning

b) Determine the current equation for sudden short circuit in an R-L series circuit. Find the conditions for D.C. component to become maximum and minimum respectively. **10 (CO1, PO1)**

3. a) A 3 phase, 200 kVA, 11 kV/400 V transformer is connected in delta-star. The C.Ts on low voltage side have turns ratio of 500/5. Find the C.T. ratio on high voltage side. Explain the operation of the relay and find the circulating current when the fault of 750 A of following types occur on the low voltage side: **15 (CO3, PO2)**
   i) Earth fault within protective zone
   ii) Earth fault outside protective zone
   iii) Phase to phase fault within protective zone
   iv) Phase to phase fault outside protective zone

Assume balanced voltage. Depict the figure for any one of the arrangements.

b) Explain the working principle of a circuit breaker for 3.3 kV voltage rating that uses atmospheric air pressure as arc extinguishing medium. (Diagram must be shown). **10 (CO3, PO2)**

4. a) Explain the working principle of Minimum Oil Break Circuit Breaker with necessary diagrams. **10 (CO3, PO2)**

b) Discuss the physical and dielectric properties of $SF_6$ circuit breaker. Explain the operation of single pressure puffer type $SF_6$ circuit breaker. **15 (CO3, PO2)**

5. a) Explain negative phase sequence relay with proper schematic diagram. Explain zero sequence currents and negative sequence currents for this type of relay with proper vector diagram. **15 (CO3, PO2)**

b) Explain harmonic restraint and harmonic blocking with proper diagram. Explain Cassie's theory with proper assumptions and justify how it described arc interruption successfully. **15 (CO3, PO2)**

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

**Date: 08 December, 2022**
**Time: 10:00AM – 01:00 PM**

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

## DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

**Semester Final Examination**
**Course Number: Math 4521**
**Course Title: Numerical Methods**

**Winter Semester: 2021 - 2022**
**Full Marks: 150**
**Time: 3 Hours**

There are **06 (Six)** questions. Answer **all** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in brackets. Assume reasonable value(s) for missing data if any.

---

1. a) The circuit shown in Fig. 1(a) contains a non-linear element with (v-i) characteristics given as $i = 0.5v + 0.1v^3 + 0.075v^5 + 0.01v^7$(A). Determine the unknown node voltage using the Newton-Raphson method. Assume an initial guess of 0.0 V. **(13) (CO1) (PO1)**

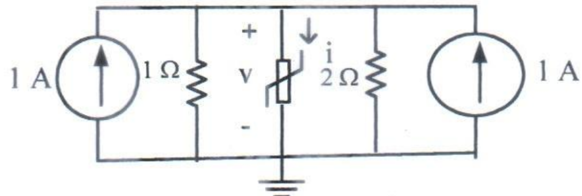


Fig. 1(a)

b) Modified secant method is an alternative approach that involves a fractional perturbation of the independent variable to estimate the derivative used in Newton-Raphson method. Use this modified method to determine the real root of $x^{3.5} = 80$, within $\varepsilon_s = 0.1\%$ using an initial guess of $x_0 = 3.5$ and perturbation $\delta = 0.01$. **(12) (CO1) (PO1)**

**OR**

Determine the root of the equation $5 - 5x = e^{0.5x}$ using an open root finding method of your choice with an initial value $x_i = 0.6$. Perform iterations until the approximate relative error falls below 2%. **(12) (CO1) (PO1)**

2. a) An electronics company produces transistors, resistors, and computer chips. Each transistor requires four units of copper, one unit of zinc, and two units of glass. Each resistor requires three, three, and one unit of the three materials, respectively, and each computer chip requires two, one, and three units of these materials, respectively. Putting this information into table form, we get: **(13) (CO1) (PO1)**

| Component | Copper | Zinc | Glass |
|---|---|---|---|
| Transistors | 4 | 1 | 2 |
| Resistors | 3 | 3 | 1 |
| Computer Chips | 2 | 1 | 3 |

Supplies of these materials vary from week to week, so the company needs to determine a different production run each week. For example, one week the total amounts of materials available are 960 units of copper, 510 units of zinc, and 610 units of glass. Solve for the number of transistors, resistors, and computer chips to be manufactured this week. Use Gauss-Seidel method with initial guess of Transistors=100, Resistors=90 and Computer Chips=70.

OR

Use the Gauss-Seidel method with relaxation ($\lambda = 1.2$) to solve the following system to a tolerance of $\varepsilon_s = 5\%$. If necessary, rearrange the equations to achieve convergence. **(13) (CO1) (PO1**

$$\begin{aligned} 2x_1 - 6x_2 - x_3 &= -38 \\ -3x_1 - x_2 + 7x_3 &= -34 \\ -8x_1 + x_2 - 2x_3 &= -20 \end{aligned}$$

**b)** An investigator has reported the measured data (V-I) of a non-linear electric circuit tabulated below. It is known that such data can be modeled by the following equation **(12) (CO1) (PO1)**

$V = e^{(I-B)/A}$.

Where, A and B are model parameters. Use a transformation to linearize this equation and then employ linear regression to determine A and B. Based on your analysis, I at V = 2.6 (V).

| V(V) | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| I(A) | 0.5 | 2.0 | 2.9 | 3.5 | 4.0 |

**3. a)** A 1μF capacitor is being charged through a 1 kΩ resistor using a 10 V battery. Determine the energy dissipated in the resistor between t = 0 to t = 1 ms using multiple applications of the trapezoidal rule. Subdivide the interval into five equal intervals. Estimate true percent relative error **(13) (CO1) (PO1)**

**b)** The open-circuit voltage $E_g$(V) of a DC generator is measured for four values of field current $I_f$ (A) as shown in the table below. **(12) (CO1) (PO1)**

| $I_f$(A) | 1.0 | 1.5 | 2.0 | 2.5 |
|---|---|---|---|---|
| Eg(V) | 180 | 210 | 215 | 217 |

Derive Newton's divided difference interpolation polynomial and hence find the value of Eg(V) at $I_f$=1.75 (A) .

**OR**

**a)** A surface in the x-y plane contains a density $\rho_s = xy^2\ \mu C/m^2$. Using trapezoidal rule find the total charge in a $5\ m \times 5\ m$ area on that surface. Use $\Delta x = \Delta y = 1\ m$. **(12) (CO1) (PO1**

**b)** A plane is being tracked by a radar and data are taken in polar coordinates **θ** and **r** as tabulated below. **(13)** **(CO1)** **(PO1**

| t(s) | 200 | 202 | 204 | 206 | 208 | 210 |
|---|---|---|---|---|---|---|
| **θ**(rad) | 0.75 | 0.72 | 0.70 | 0.68 | 0.67 | 0.66 |
| **r** (m) | 5120 | 5370 | 5560 | 5800 | 6030 | 6240 |

At 206 s, use the central finite difference (second order correct) to find the acceleration $\vec{a}$ . In polar coordinate

$$\vec{a} = (\ddot{r} - r\dot{\theta}^2)\vec{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\vec{e}_\theta .$$

**4. a)** A total charge Q is uniformly distributed around a ring-shaped conductor with radius **a**. A charge **q** is located at a distance **x** from the center of the ring as shown in Fig.4 (a). The force exerted on the charge by the ring is given by, **(12)** **(CO2)** **(PO2)**

$$F = \frac{1}{4\pi\varepsilon_0}\frac{Qqx}{(x^2+a^2)^{3/2}} .$$

Where, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/(N.m^2)$, $q = Q = 2 \times 10^{-5}\ C$, and $a = 0.9\ m$ . Determine the distance **x** where the force is a maximum.

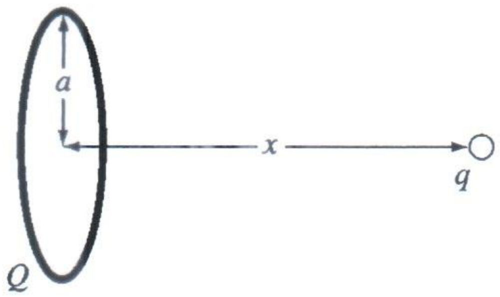


Fig. 4(a)

**b)** The inner conductor with negligible thickness of a shielded rectangular cable as shown in Fig. 4(b) is maintained at a potential of 100 V. Derive the matrix equation for potentials at the interior points using Finite Difference scheme of the Laplace Equation and show four iterations. **(13)** **(CO2)** **(PO2)**

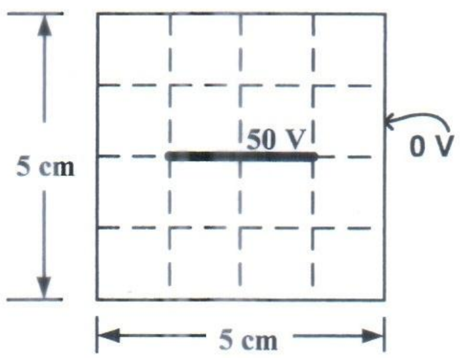


Fig. 4(b)

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5 a) How is the goodness of fit of least square curve measured? (5) (CO2) (PO2)

b) The current flowing through a capacitor is $i(t) = 10e^{-t}$ (A) for $t > 0$. Using the two-point Gauss-Legendre formula (A particular form of Gauss Quadrature formulas), find the charge accumulated in the capacitor between time $t = 0.5\ to\ 1.0$ s. Also determine the true percentage of relative error. (10) (CO3) (PO2)

c) How is a stiff system identified? What restrictions should be imposed in solving a stiff differential equation $\frac{dy}{dt} = -ay$, to ensure stability in solution using Euler's method? How can the algorithm be made unconditionally stable? (10) (CO3) (PO2)

6. a) A practical resistor may not always obey Ohm's law. For example, the voltage drop may be nonlinear, and the circuit dynamics for a source free R-L circuit is described by a relationship such as, 10 (CO3) (PO2)

$$L\frac{di}{dt} + R(i - i^3) = 0$$

Solve for $i$ using Euler's method if L=1 H, R=1.5 Ω and i(0)=0. 5 A from t=0 to 1 s with a step size=0.2 s.

b) The circuit in Fig.6 (b) has reached steady state at $t = 0_-$. If the make before break switch moves to position b at $t = 0$, find $i(t)$ for $t = 0\ to\ 0.1\ s$ with a step size =0.02 s 15 (CO3) (PO2)

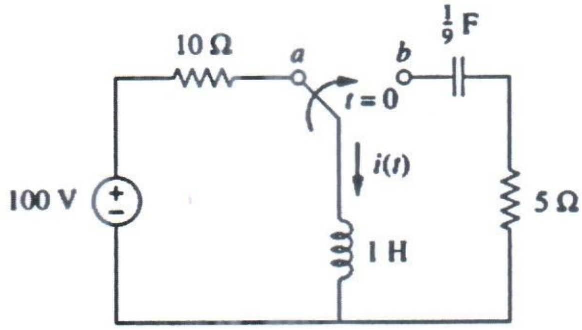


Fig.6(b)

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**Name of the Program:** B.Sc. in EEE
**Semester:** $5^{th}$

**Date:** 12 December, 2022
**Time:** 10:00 am – 1:00 pm

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

Semester Final Examination
Course No.: EEE 4541
Course Title: Wireless Communication

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) Formulate Friis Free Space equation. **12 (CO1, PO1)**

   b) Consider two-ray model with a long distance between the transmitter and the receiver. At the distance of 2 km from the transmitter, the magnetic field intensity is 2 amp/meter in the air. The operating frequency is 3 GHz. The gain of the receiving antenna is 20 dBi. Calculate the received power at the distance of 4 km from the transmitter. **13 (CO2, PO2)**

2. a) Define circular polarization. Write down the 3GPP Release number that has introduced further enhanced Licensed Assisted Access (feLAA). **6 (CO1, PO1)**

   b) If we use 200 GHz carrier frequency, instead of the current use of lower frequencies, determine the additional advantages and the additional disadvantages that will be obtained. **7 (CO1, PO1)**

   c) There is a knife-edge blockage between a transmitter and a receiver. The blockage blocks 6 Fresnel zones fully and it does not partially block any Fresnel zone. Determine the value of Fresnel-Kirchoff diffraction parameter. **12 (CO2, PO2)**

3. a) There are a lot of trees in an area. If the airflow increases, determine whether the fading condition will improve, deteriorate, or remain unchanged, in terms of slow or fast fading conditions. Give reasons briefly. **6 (CO1, PO1)**

   b) Assume that a cellular operator has deployed 5G cellular communication with wide bandwidth in a few villages in Bangladesh. However, the villagers do not experience a good data rate. Determine the possible reasons for the poor data rate. **7 (CO1, PO1)**

   c) Both A and B are Tier 1 ISPs. A sends 100 Terabytes to B and B forwards these data. B sends 50 Terabytes to A and A forwards these data. Determine how much A should pay B (in US Dollars). **12 (CO2, PO2)**

4. a) State the reason for the popularity of empirical path loss models. Determine the function of Interconnection Exchange (ICX) when a Grameenphone user talks with another Grameenphone user. **7 (CO1, PO1)**

   b) Determine what would be the problem if the audio bandwidth was chosen 10 kHz for FM radio broadcast. Explain why the first stage amplifier of a wireless receiver is made with as little noise as possible. **8 (CO1, PO1)**

c) For AM radio broadcast, the center frequency of the Image Signal is 1.5 MHz. Determine the carrier frequency of the desired signal? **10 (CO2, PO2)**

5. a) Discuss the extended Discontinuous Reception (eDRX) procedure. Explain why Infrared (IR) communication has lost its popularity in many cases. **8 (CO1, PO1)**

b) Determine which applications are delay sensitive from the following list. **7 (CO1, PO1)**

i. Web browsing
ii. Voice
iii. Buffered streaming video
iv. FTP
v. Vehicle-to-vehicle (V2V) communication
vi. Real-time gaming
vii. Industrial IoT (IIoT)

c) An LTE user has moved closer to the base station. Determine which of these parameters should decrease: CINR, EVM, modulation level, code rate, CQI, transmit power, amount of radio resources allocated, amount of packet retransmissions, and data rate. **10 (CO1, PO1)**

6. a) For a new wireless communication project that wants to cover the whole earth using satellites, determine the advantages and disadvantages, if a low height is chosen for the satellites. **7 (CO1, PO1)**

b) Define fade margin. Define Carrier Sense Multiple Access with Collision Detection (CSMA/CD). **8 (CO1, PO1)**

c) There are five terminals A, B, C, D, and E in a local wireless network. Request-to-Send (RTS) and Clear-to-Send (CTS) are not used in this network. For any of the terminals, the coverage area is circular with the terminal placed at the center. The locations of the terminals with respect to their coverage areas are shown in Figure 1. C sends data to D. Determine the terminals between which Hidden Terminal Problems and Exposed Terminal Problems may occur. **10 (CO2, PO2)**

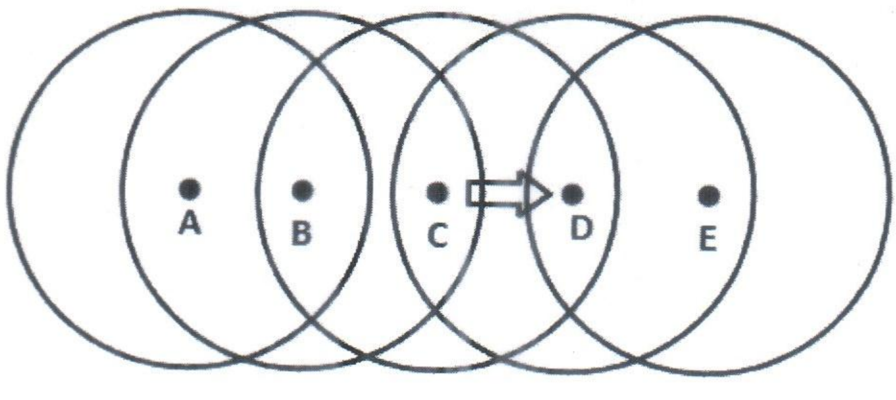


Figure 1

B.Sc. in EEE, 5th Semester | December 02, 2022
10:00 am – 01:00 pm

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

Semester Final Examination | Winter Semester, A. Y. 2021-2022
Course No.: EEE 4551 | Time: 3 Hours
Course Title: Data Communication and Networking 1 | Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) During the COVID-19 pandemic period, Bangladesh Government hires you as the network expert. Your task is to build a long-term network solution between all the intensive care units (ICUs) and the hospitals inside Dhaka city so that the Institute of Epidemiology, Disease Control and Research (*IEDCR*) can stay connected and receive real-time patient data. **15 (CO3, PO2)**

   Assume that on average, 100 patients are affected per day. On average, ten patients (10%) are admitted to ICU and stay for approximately 14 days.

   As a network designer, your task is to design Intra-Networks among the devices within the Hospitals and Inter-Networks among the hospitals. Explain your network solution and justify your preferred basic network components based on your design (i.e., end devices, routers, switches, hubs, bridges, cables, etc.). Your planned networks should be able to handle new patients for the next 6 months to a year.

   Use appropriate illustrations, diagrams, tables, and flowcharts as much as possible while designing your network and answering the following connected questions.

   b) While designing your above-mentioned network solution - **20 (CO3, PO2)**

   i) Explain why you prefer the four layers of the Internet protocol stack (TCP/IP model).
   ii) Describe the primary responsibilities of each of these layers in your network design.
   iii) Explain briefly the Protocol Data Units (PDU), Header, and Trailer in TCP/IP data encapsulation that handle intra- and inter-network data transmission.
   iv) Describe briefly how the following responsibilities are carried out within the layer: i) application-layer message, ii) transport-layer segment, iii) network layer datagram, and iv) link-layer frame.
   v) Determine which layers of the Internet protocol stack handle the routing of your overall network solution.
   vi) Explain why the Transport layer is referred to as the "heart" of your design's OSI model.
   vii) Explain briefly how the Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP) deal with connection-oriented and connectionless services.
   viii) Discuss briefly how do you determine the IP addresses and subnet masks of your network solution.

c) While designing your above-mentioned network solution, briefly explain and justify your preferred routing algorithms (or combinations of routing algorithms) from the following: Shortest-Path, Flooding, Flow-based, Distance-Vector, Link-State, Hierarchical, Broadcast, and Multicast. Use appropriate illustrations, diagrams, tables, and flowcharts. **15 (CO3, PO2)**

2. a) Discuss the features of Ethernet. Mention the various transmission rates of Ethernet LANs. **6 (CO1, PO1)**

b) Explain the significance of throughput in data transfer in networking. If throughput is not considered perfectly, determine the cause of the bottleneck. Use appropriate illustrations. **14 (CO2, PO2)**

Suppose Sec-A at room 201 wants to send a large file of Energy-Data-Logger to Sec-B at room 202. The path from Sec-A at room 201 to Sec-B at room 202 has six links, of rates $R_1 = 3$ Mbps, $R_2 = 7$ Mbps, $R_3 = 500$ kbps, $R_4 = 750$ kbps, $R_5 = 1$ Mbps, and $R_6 =$ 300 kbps.

i) Determine the throughput for the file transfer, assuming no other traffic on the network.
ii) Assume the file has 4 million bytes. How long will it take to transfer the file to Sec-B in Room 202 if the file size is divided by the throughput?
iii) Repeat (i) and (ii), but this time with $R_2$ reduced to 100 kbps.

3. a) As a network designer, briefly explain the benefits of using a protocol suite. Explain the drawbacks that occur among network components when there is no protocol suite. Discuss the function of interoperability and the significance. of protocol standards. **7 (CO1, PO1)**

b) Explain the significance of protocol layering in the protocol suite with appropriate illustrations. **8 (CO1, PO1)**

4. a) Consider a packet of length $L$, which begins at end system A and travels over three links to a destination end system B. Two packet switches connect these three links. Let $d_i$, $s_i$, and $R_i$ denote the length, propagation speed, and transmission rate of link $i$, respectively ($i$ = 1, 2, 3). The packet switch processing delay by each packet is $d_{proc}$. Assuming no queuing delays, in terms of $d_i$, $s_i$, $R_i$, ($i$ = 1,2,3), and $L$, determine the total end-to-end delay for the packet. **15 (CO2, PO2)**

Suppose the packet is 1,500 bytes, the propagation speed on all three links is the same, i.e., $2.5 \times 10^8$ m/s, the transmission rate of all three links is the same, i.e., 2 Mbps, the packet switch processing delay is 3 msec, the length of the first link is 5,000 km, the length of the second link is 4,000 km, and the length of the last link is 1,000 km. Now determine the total end-to-end delay for the packet.

b) Explain the importance of routing tables and their working principles with appropriate illustrations. **5 (CO1, PO1)**

5. a) Suppose you want to send 100 data from a source to a destination. Using appropriate illustrations, explain how data communicates through the following switching methods: i) Circuit switching and ii) Packet switching. **10 (CO2, PO2)**

Identify and explain which method is superior: i) in terms of guaranteed service, and ii) in terms of faster delivery time.

b) Consider the circuit-switched network in the following Figure 5(b). There are 4 circuits on each link. The four switches, A, B, C, and D, go in a clockwise direction. **10 (CO2, PO2)**

i) Determine the maximum number of simultaneous connections that can be active in this network at any given time.
ii) Assume all connections are made between switches A and C. Determine the maximum number of concurrent connections that can be active.
iii) Suppose you want to make four connections between switches A and C, and another four connections between switches B and D. Explain how you will route these calls through the four links in order to accommodate all eight connections.

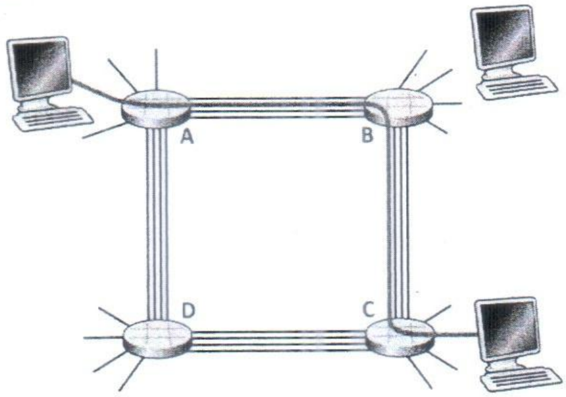


Figure 5(b).

6. a) Packet switching is more efficient than circuit switching for data communication over the internet using layering protocols. Explain the difference between packet switching and circuit switching. **20 (CO2, PO2)**

Justify your design mechanism for the following issues when multiple data streams are being transferred for effective packet switching:

i) The mechanism used to identify each destination.
ii) Proper synchronization of each sender and corresponding destination.
iii) Suitable packet size and rate to effectively control data loss, packet delay, and throughput requirements.
iv) Proper mechanism to handle packet collision and recognize each packet's beginning and end.
v) Proper coordination among the shared network so that each network can ensure equal opportunity to transfer the data.

b) Suppose you urgently want to deliver 40 terabytes of data from IUT to OIC Head-quarter. You have a 100 Mbps dedicated link for data transfer. **5 (CO2, PO2)**

Identify whether you send the data via this link or via FedEx overnight delivery. Explain and justify your answer.

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B.Sc. TE. (2-Yr), 1st Sem.

Date: November 30, 2022
Time: 10:00 AM- 1:00 PM

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

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

Semester Final Examination
Course No.: EEE 4597
Course Title: Telecommunication Principles

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **8 (eight)** questions. Answer **any 6 (six)** 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 bear their usual meanings. Make reasonable approximation(s) for missing information.

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1. a) How can we distinguish narrowband and wideband FM in terms of their modulation index values? Write the bandwidth expression from Carson's rule considering both sinusoidal modulation and non-sinusoidal modulation. Why is pre-emphasis necessary? What sort of filter is equivalent to a de-emphasis network? 9

   b) For the FM signal, $s(t) = A_c \cos[2\pi f_c t + \beta \sin(2\pi f_m t)]$; derive the equation of narrowband FM. 8

   c) Consider an FM signal obtained from a modulating signal frequency of 2 kHz and maximum amplitude of 5 V. Find the bandwidth using Carson's rule and considering the significant sideband frequencies. Also comment on the accuracy of different methods in determining the bandwidth. [Hints: datasheet attached with the question can be used] 8

2. a) Derive the expression for sideband power and total power for amplitude modulation and from them, find the expression for modulation efficiency. Show that a major portion of the power is utilized for transmitting the carrier in amplitude modulation. 9

   b) An audio frequency signal $10\sin(10^3\pi t)$ is used to amplitude modulate a carrier of $50\sin(2\pi 10^5 t)$. Calculate: 12
   i) Modulation index, ii) Sideband frequencies, iii) Amplitude of each sideband, iv) Bandwidth required, v) Total power delivered to the load of 500 Ω and vi) Modulation efficiency.

   c) Compare between UTP and STP cable. Which coaxial cable type is mainly used for video transmission? 4

3. a) For an analog sinusoidal signal show its PAM, PPM, PWM version. What is clipped PPM? 5+2

   b) Name the cellular technologies for various generations of 3GPP and 3GPP2 starting from 2.75G. 6

   c) What sort of filter is equivalent to a pre-emphasis network? Draw the overall block diagram of FM containing pre-emphasis and de-emphasis networks. A carrier wave of frequency 91 MHz is frequency modulated by a sine wave of amplitude 10 volts and frequency 15 kHz. The frequency sensitivity of the modulator is 3 kHz / V. 5+7
      i. Determine the approximate bandwidth of FM wave using Carson's rule.
      ii. Repeat part (i), assuming that the amplitude of the modulating wave is doubled, and frequency is halved.

4. a) Represent the bit stream 10101110 with unipolar, polar, bipolar and Manchester signaling including both RZ and NRZ schemes. 12

b) A constellation diagram consists of 64 equally spaced points on a circle. If the baud rate is 5 kbps, what is the bit rate? Draw the constellation diagram of 8-PSK. Show a representation of 16-QAM using 2 amplitude, 8 phase level and 3 amplitude, 12 phase level. 13

5. a) Design a DSB-SC modulator for generating a modulated signal $km(t)\cos\omega_c t$ ; where m(t) is a signal band-limited to B Hz and the carrier generator generates $\cos^3\omega_c t$. Explain how you can generate the desired signal including filter type, signal spectra before and after filtering. Also find whether this scheme will work if the carrier generator produced $\cos^2\omega_c t$ in place of $\cos^3\omega_c t$ and measure the minimum usable value of $\omega_c$. 15

b) Explain maximum radian frequency deviation of the angle modulated signal. How can we express the angle modulated signals incorporating their respective deviation constants? 10

6. a) Derive Rayleigh-Jeans approximation from Planck's Blackbody radiation law. From this find a measure of the power delivered to the load resistor in bandwidth B at an equivalent noise temperature T. 12

b) Define angle modulation. How is it different from amplitude modulation? Show that the fourier spectrum of an angle modulated signal is not related to the message signal spectrum in any simple way as amplitude modulation. 13

7. a) Explain the operation of an envelope detector. 10

b) Design an indirect FM transmitter with $f_1 = 200\ kHz$, $\Delta f_1 = 20Hz$, $f_{LO} = 10.8\ MHz$, $n_1 = 64$ and $n_2 = 48$. Compute the carrier frequency and maximum frequency deviation of the output of this transmitter. 15

8. a) A certain AM transmitter radiates 10 kW with the carrier un-modulated, and 11.8 kW when the carrier is sinusoidally modulated. Calculate the modulation index. If another sine wave, corresponding to 30% modulation, is transmitted simultaneously, determine the radiated power. 8

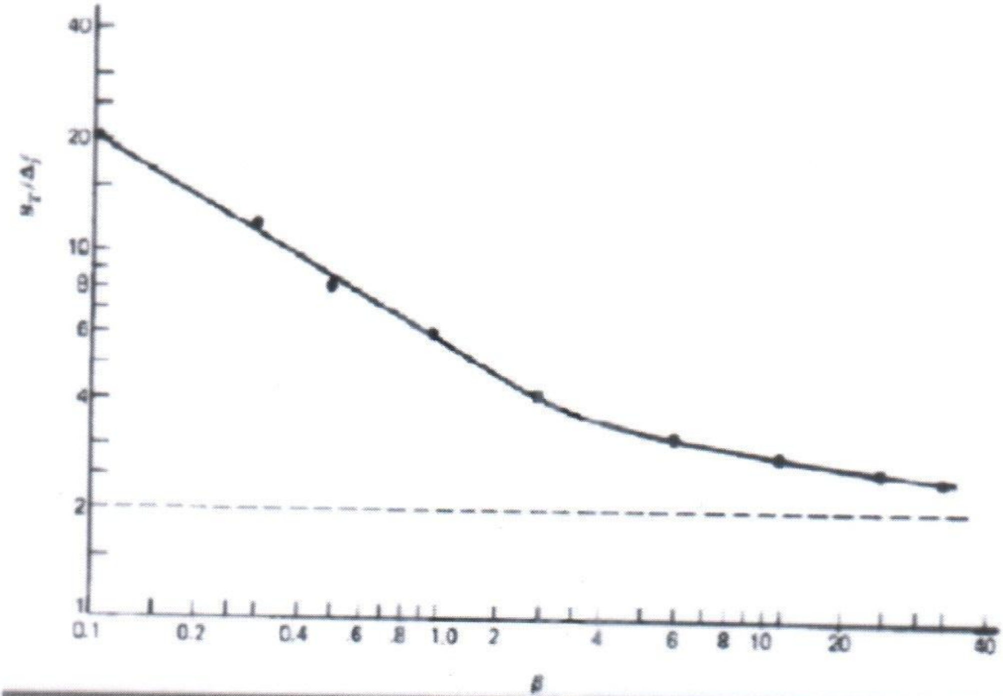
b) The output current of 60% modulated AM generator is 1.5 A. To what value will this current rise if the generator is modulated additionally by another audio wave, whose modulation index is 0.7? What will be the percentage power saving if the carrier and one of the sidebands are now suppressed? 12

c) Name a cellular technology deployed with TDD version only. Mention the 3GPP cellular technologies along with their generations which used TDMA/FDMA as their multiplexing techniques. 5

**Datasheet for Question 1(c):**

Number of Significant Side Frequencies
of a Wide-band FM Signal for Varying Modulation Index

| Modulation Index $\beta$ | Number of Significant Side Frequencies $2n_{max}$ |
|---|---|
| 0.1 | 2 |
| 0.3 | 4 |
| 0.5 | 4 |
| 1.0 | 6 |
| 2.0 | 8 |
| 5.0 | 16 |
| 10.0 | 28 |
| 20.0 | 50 |
| 30.0 | 70 |




*Universal Curve for evaluating the bandwidth of FM wave*

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B.Sc. in EEE, 7th Semester

December 01, 2022
10:00 am – 1:00 pm

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

Semester Final Examination
Course No.: EEE 4701
Course Title: Digital Signal Processing

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) "Up-Sampling is a Time-Variant operation" - justify this statement with an example. **12 (CO1, PO2)**

   b) Show that the response of an LTI system to the input x(n) can be defined as, **13 (CO1, PO2)**

$$y(n) = \sum_{k=-\infty}^{\infty} x(k)h(n-k)$$

2. a) Determine the output y(n) of a relaxed LTI system with the impulse response, **12 (CO1, PO2)**

$$h(n) = b^n u(n) \text{ , where } |b| < 1,$$

   when the input is a unit step sequence.

   b) Graphically illustrate that an infinitely long pure sinusoidal signal has only one frequency component according to Fourier Transform. **13 (CO2, PO1)**

3. a) Determine $x(n)$ from its Fourier Transform, **12 (CO2, PO1)**

$$X(e^{j\omega}) = j * sin(\omega) * [5 + 6\left(\frac{e^{j\omega}+e^{-j\omega}}{2}\right) + 2\left(\frac{e^{j\omega}+e^{-j\omega}}{2}\right)].$$

   b) For a seven-point moving average system analyse and approximately sketch the magnitude and phase response. **13 (CO2, PO1)**

4. a) Illustrate the effects on the signal reconstruction for the system having non-linear phase response? Illustrate it with an example. **12 (CO2, PO1)**

   b) Illustrate the use of an All-pass-filter after an IIR filter. Illustrate it with an appropriate example. **13 (CO2, PO1)**

5. a) The band of the original signal is 0 to 5 kHz. Due to the power line effect 50 Hz signal has been added with the original signal. Design a filter to suppress the 50 Hz noise signal and up to its 3rd harmonics. Show the pole-zero position approximately of the designed filter on the Z-plane. **12 (CO3, PO2)**

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b) For the following magnitude response, compose the poles and zeros in the Z-plane. **13 (CO3, PO2)**

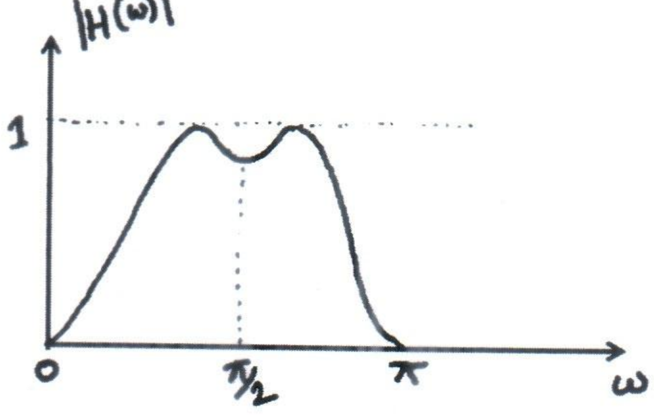


Fig: 5 (b)

6. a) With a proper diagram illustrate that circular convolution is one kind of linear convolution. Show the steps to perform circular convolution for a discrete system with an example. **12 (CO2, PO1)**

b) Find and illustrate the approximate magnitude response by using DFT for the following sequence: **13 (CO2, PO1)**

$$x(n) = 2\cos\left(2\pi\frac{3}{8}n\right), where\ N = 10.$$

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

**Date:** 7th December, 2022
**Time:** 10:00 am – 1:00 pm

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

## DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

**Semester Final Examination**
**Course Number: EEE 4703**
**Course Title: Communication Engineering II**

**Winter Semester: 2021 - 2022**
**Full Marks: 150**
**Time: 3 Hours**

There are **6 (six)** questions. Answer **all 6 (six)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

---

1. a) Distinguish between coherent and non-coherent demodulation. List different modulation schemes under the two headings. **10** **(CO1, PO1)**

   b) A system using matched filter detection of equally likely BPSK signals, $s_1(t) = \sqrt{2E/T}\cos\omega_0 t$ and $s_2(t) = \sqrt{2E/T}\cos(\omega_0 t + \pi)$, operates in AWGN with a received $E_b/N_0$ of 6.8 dB. Assume that $E\{z(T)\} = \pm\sqrt{E}$. **15** **(CO2, PO2)**
   (i) Find the minimum probability of bit error, $P_B$, for this signal.
   (ii) If the decision threshold is $\gamma = 0.1\sqrt{E}$, find $P_B$.

2. a) Deduce the condition for high SER for MPSK. **10** **(CO1, PO1)**

   b) Design an $(n, k) = (5, 2)$ linear block code. **15** **(CO2, PO2)**
   (i) Choose the codewords to be in systematic form and choose them with the goal of maximizing $d_{min}$.
   (ii) Find the generator matrix for the codeword set.
   (iii) Calculate the parity-check matrix.

3. a) Show that the probability of error of a BPSK signaling system is equal to M-PAM signaling system. **10** **(CO1, PO1)**

   b) Find the expected number of bit errors in one day by the following continually operating coherent BPSK receiver. The data rate is 5000 bits/s. The input digital waveforms are $s_1(t) = A\cos\omega_0 t$ and $s_2(t) = -A\cos\omega_0 t$ where $A = 1$ mV and the single-sided noise power spectral density is $N_0 = 10^{-11}$ W/Hz. Assume that signal power and energy per bit are normalized relative to a 1 Ω resistive load. **15** **(CO2, PO2)**

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4. a) Derive the overall probability of symbol error of QPSK scheme. **10** **(CO1, PO1)**

b) Figure 4(b) is a representation of convolutional encoder. Assume that a received message from this encoder is 1 1 0 0 1 0. Using Viterbi algorithm (trellis diagram) find the transmitted sequence. **15** **(CO3, PO2)**

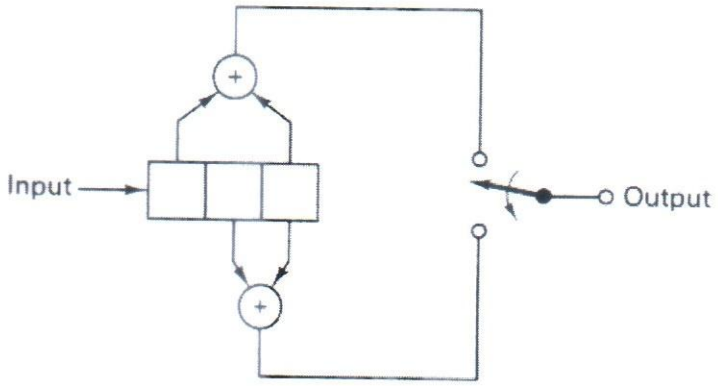


Fig. 4(b)

5. a) Consider a (7,4) code whose generator matrix is **15**

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

**(CO3, PO2)**

i) Find all the codewords of the code,
ii) Find **H**, the parity-check matrix of the code.

b) Construct a triple error-correcting BCH code with block length n = 31 over GF ($2^5$). [Hints: (n, k) = (31,16)] **10**

6. a) Construct a systematic cyclic code (7, 4) using generator polynomial g(x) = x3+x2+1, with message (1 0 1 0). **15**

b) Determine binary trees and Huffman codes for the following source statistics: **10** **(CO3, PO2)**

| Symbol | S0 | S1 | S2 | S3 | S4 | S5 | S6 | S7 |
|---|---|---|---|---|---|---|---|---|
| Probability1 | 0.20 | 0.20 | 0.15 | 0.15 | 0.1 | 0.1 | 0.05 | 0.05 |
| Probability2 | 0.3 | 0.25 | 0.1 | 0.1 | 0.075 | 0.075 | 0.05 | 0.05 |

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

Date: December 06, 2022
Time: 10 AM 1:00 PM

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

Semester Final Examination — Winter Semester, A. Y. 2021-2022
Course No.: EEE 4503 — Time: 3 Hours
Course Title: Power Electronics — Full Marks: 150

**There are 6 (six) questions. Answer all 6 (six) questions. Note that question no.4 and question no. 6 have options.**

Marks in the margin indicate full marks. Do not write on this question paper. Assume reasonable value for any missing data. Marks of each question and corresponding COs and POs are in brackets.

---

1. a) Define a power electronic system with the proper block diagram. Briefly state that in what basis a controller generates switching signal for the power processor in the system. 08 (CO1, PO1)

   b) Distinguish between the dc output voltages of an uncontrolled single phase bridge rectifier with and without source inductances for the highly inductive load. For both cases formulate the expression of output voltages sketching the circuit diagrams with waveshapes of necessary responses if a sinusoidal input is applied. 08 (CO2, PO2)

   c) The input voltage of the following converter is 230 V (rms), 50 Hz. The load current is 10 A continuous. If the power supplied to the load is 1.5 kW, (i) determine the firing angles for $T_1$ and $T_2$, (ii) sketch the waveshapes of $i_s$ and $V_O$. (iii) Compare output voltage waveshapes if $D_m$ is removed with if $D_m$ is there. 09 (CO2, PO2)

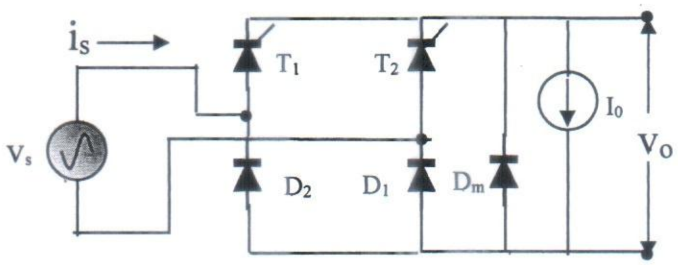


Fig. Q. 1(c)

2. a) Discuss on the advantages of a multi-phase rectifier over a single phase rectifier. Depict a multi-phase star rectifiers and find the expression of the dc output voltage. Explain how the frequency of the instantaneous output voltage can be increased. 08 (CO1, PO1)

   b) Depict the circuit diagram of a three bridge rectifier and the line to line voltages. Identify the devices operating in various portion of the voltages. Formulate the dc and rms value of the output voltages. 08 (CO1, PO1)

   c) A three phase bridge rectifier is supplying a purely resistive load. Find (i) the efficiency (ii) the FF , (iii) The RF (iv) PIV of each diode in terms of peak value of phase voltage $V_m$ 09 (CO2 PO2)

3. a) (i) Identify the main problems of using two thyristors for a bidirectional ac controller.
   (ii) Depict a circuit to overcome this problem.
   (iii) If the supply voltage of an ac controller is 220 V (rms) 50 Hz, find the firing angle of your thyristors/thyristor to have 100 V (rms) output voltage for a resistive load? 08 (CO2, PO2)

b) A single-phase full-wave ac controller with an R-L load is supplied with an rms voltage $V_S$=120 V, f=60 Hz. The load inductance is L=6.5 mH. The thyristors are fired at $\alpha_1 = 60^0$ and $\alpha_2 = \pi + 60^o$, respectively. The thyristor 1 ceases conduction at $\beta = 240^0$. 09 (CO2, PO2)

(i) Find the value of load resistance.

(ii) For this load, if $\alpha_1$ is made less than $60^0$, sketch the output voltage of the controller.

c) An ac controller has a resistive load of R=10 Ω and the input is 220 V, 50 Hz. The thyristors switch is on for n=25 cycles and for m=75 cycles. Determine 08 (CO2, PO2)

(i) the rms value of the output voltage,

(ii) the input power factor,

(iii) the average and rms current through thyristors.

4\. a) Draw the circuit diagram of a step down dc to dc converter with RL load. Suppose the converter is operating in the discontnuous mode. Define the time interval of the converter after the switch is off with proper expression. 13 (CO1, PO1)

b) A step-down converter is feeding an RL load with $V_S$=220 V, R=5 Ohm and L=7.5 mH, f=1 KHz, k=0.5. Find (i) the minimum and maximum values of instantaneous load current (ii) maximum peak to peak load ripple current (iii) the average value of the load current. 12 (CO2, PO2)

**OR**

4\. a) Sketch the circuit diagram of a buck regulator. Drawing the wave-shapes of various branch currents clearly identify which current accounts for the ripple of the output voltage. Find the expressions of the ripple inductor current and ripple voltage at the output. 13 (CO1, PO1)

b) The buck regulator has an input voltage 15 V. The required average output voltage is 5 V. and peak to peak output voltage is 10 mV. The switching frequency is 20 kHz. The peak to peak inductor current ripple is 0.5 A. Find (i) duty cycle (ii) the filter inductance (iii) the filter capacitance and (iv) the critical inductance and capacitance. 12 (CO2, PO2)

5\. a) (i) The CU'K converter has a distinct feature that makes it superior over the conventional buck-boost converter. Explain the feature. (ii) Depicting the circuit diagram of the CU'K converter, describe the operating principle for ON and OFF modes of power switch. (iii) Equating the volt-radian of inductors, find the expression of output voltage. 12 (CO1, PO1)

b) In a CU'K converter operating at 50 kHz, $L_1 = L_2$=1 mH and $C_1$=5 μF. The output capacitance is sufficiently large to yield an essentially constant output voltage. Here $V_d$= 10 V and the output $V_o$ is regulated to be constant at 5 V. It is supplying 5 W to a load. Assume ideal components. Discuss on the percentage errors in assuming constant voltage across $C_1$ or in assuming constant currents $i_{L1}$ and $i_{L2}$. 13 (CO2, PO2)

6\. a) Write the circuit operation of a single-phase full-bridge inverter. Sketch the wave-shapes of output voltage and current for an inductive load. Identfy the swiching states in a table of the above inverter to obtain an ac voltage. 12 (CO1, PO1)

b) A single phase full bridge inverter is supplying a resistive load of 10 Ω and its input is taken from an uncontrolled bridge rectifier where a transformer has been used whose secondary voltage is 53.5 V (RMS). Find (i) the rms output voltage at the fundamental frequency $V_{o1}$, (ii) the output power $P_o$ (iii) the average and peak currents of each transistor and (iv) the THD. 13 (CO2, PO2)

**OR**

6 a) (i) Describe the working priciple of induction heating. Write some of the industrial applications of induction heating 12 (CO1, PO1)

(ii) Identifythe main differences beween IPS and UPS

b) For a three phase 50 Hz inverter, sketch the gating signals for 180 degree or 120 degree conduction and find the expressions of line to line voltage. If a Y load of R=10 ohm, and L= 10 mH per phase is connected to this inverter, calculate the line currents. 13 (CO2, PO2)

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B.Sc. in EEE, 7th Semester

December 05, 2022
10:00 am – 1:00 pm

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

Semester Final Examination
Course No.: EEE 4705
Course Title: Microcontroller Based System Design

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are 2 (two) sets of questions. SET A contains 4 (four) questions where you have to answer all of them. SET B contains 2 (two) questions where you have to answer any one. 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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SET A (ALL QUESTIONS ARE **COMPULSORY**)

1. a) Design a binary-ASCII converter. **13 (CO2, PO2)**
Use assembly language to convert an 8 bit binary (hex equivalent) data to corresponding ASCII and save them following the Little-Endian convention (low digit in the lower address location and high digit in the higher address location). Assume that the binary data is available through port P1 of AT89C51. Break down your code into two subroutines; one that converts binary to decimal, and two, which converts the corresponding decimal to ASCII.

b) Design a frequency generator with an AT89C51. **13 (CO2, PO2)**
A frequency of 10 Hz should be created on pin P3.6. Choose an appropriate XTAL frequency for your code.

c) Illustrate an interrupt based design by simultaneously carrying out the following three tasks in an AT89C51: **17 (CO3, PO3)**
   i. Ten hex numbers are stored in RAM locations 50H onwards. Write a program to find the biggest number in the set and save it in 60H.
   ii. Carry out the task in question (1.b).
   iii. Assume an LED is connected to P3.2 which glows whenever the 8 bit binary data is available in P1. The illuminated LED signifies that the corresponding line has gone low. Carry out the conversion of question (1.a) whenever the LED glows. Assume the LED turns off automatically once the conversion process is initiated.

d) With XTAL=11.0592 MHz, find the TH1 value needed to have the following baud rates in AT89C51: **07 (CO1, PO1)**
   i. 9600
   ii. 2400
   iii. 1200

2. a) Design a BCD adder. Assume 8 BCD data items are stored in RAM locations starting from 50H onwards. Find the sum of all these numbers and store the result in some memory locations. [The result must be in BCD] **10 (CO2, PO2)**

b) Design a counter for counting the pulses of an input signal. The pulses to be counted are fed to pin P3.4 of an AT89C51. Given XTAL = 22 MHz. Justify your design. **15 (CO2, PO2)**

3. a) Illustrate the connection between two 16K×8 Data RAMs and an AT89C51. Find the address space allocated to each data RAM based on your connection. You need to design your own decoder using simple logic gates. **13 (CO2, PO2)**

   b) Design a program which will read an array of 10 bytes, stored in the starting address of one your connected data RAMs, and transfer it to internal RAM locations starting from 50H. **12 (CO3, PO3)**

4. a) Design an electrical circuitry to connect two 8K×8 Data RAMs, one 8K×8 Data ROM, and one 8K×8 Program ROM with a ROMless version of AT89C51. Use 74LS138 3-8 decoder in your connection. [Include the truth table for your decoder.] **17 (CO4, PO3)**

   b) Determine the address range for each of the connected memory chips. **08 (CO1, PO1)**

<u>SET B (ANSWER ANY **ONE** BETWEEN 5 AND 6)</u>

5. a) Design a system that will count the number of people entering or leaving a room using a MAX1112 ADC. Assume an infra-red sensor is connected to one of the channels of the ADC. Show necessary connections and find out the control byte based on your connection. Justify your connections to the REFIN, COM, DGND and AGND pins. **12 (CO4, PO3)**

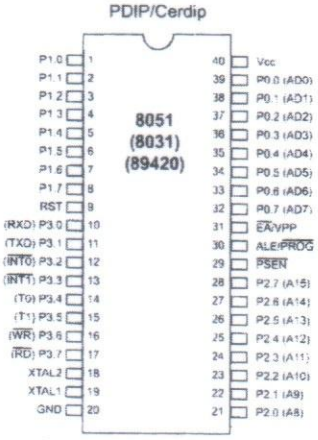
   b) Generate an assembly code that will send out the control byte to the ADC from your AT89C51 and receive the digital data (number of people) from the ADC after conversion. The received data should be sent to P1 for conversion into ASCII. **13 (CO3, PO3)**

*OR*

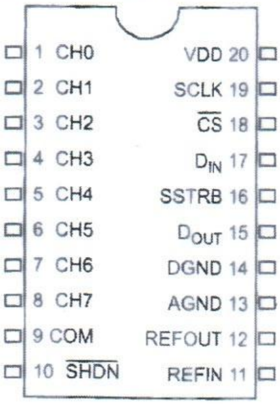
6. a) Design a system that will count the number of people entering or leaving a room using an ADC0848. Assume an infra-red sensor is connected to one of the channels of the ADC. Show necessary connections and graphically summarize the steps for selecting a channel and read timing for the ADC. Justify your connections to the Vref, DGND and AGND pins. **12 (CO4, PO3)**

   b) Generate an assembly code that will select the specific channel based on your connection and read the data (number of people) from the ADC after conversion. The received data should be sent to P1 for conversion into ASCII. **13 (CO3, PO3)**

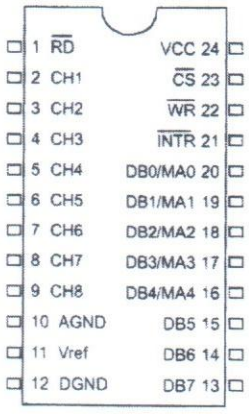
*<u>Supplementary information</u>*




8051/31 Chip




MAX1112 Chip




ADC0848 Chip

# 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 C | Flag OV | Flag AC | Instruction | Flag C | Flag OV | Flag AC |
|---|---|---|---|---|---|---|---|
| ADD | X | X | X | CLR C | O | | |
| ADDC | X | X | X | CPL C | X | | |
| SUBB | X | X | X | ANL C,bit | X | | |
| MUL | O | X | | ANL C,/bit | X | | |
| DIV | O | 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,@ *(jump if A != data)* | | cjne A,#data,@ | | | | |
| **je** A, #data,@ *(jump if A == data)* | | add A,#low( data)<br>jz @ | or | <br><br>ne: | cjne<br>jmp<br>... | A,#(data),ne<br>@ |
| **ja, jnbe** A,#data,@ *(jump if A > data)* | | add A,#low( data 1)<br>jc @ | or | <br>ne: | cjne<br>jnc | A,#(data+1),ne<br>@ |
| **jae, jnb** A,#data,@ *(jump if A >= data)* | | add A,#low( data)<br>jc @ | or | <br>ne: | cjne<br>jnc | A,#(data),ne<br>@ |
| **jb, jnae** A,#data,@ *(jump if A < data)* | | add A,#low,( data)<br>jnc @ | or | <br>ne: | cjne<br>jc | A,#(data),ne<br>@ |
| **jbe, jna** A,#data,@ *(jump if A <= data)* | | add A,#low( data 1)<br>jnc @ | or | <br>ne: | cjne<br>jc | A,#(data+1),ne<br>@ |
| **switch** A <,==,> #data *(no A modification)* | <br><br>ne: | cjne A,#data,ne<br>...<br>jc is_below<br>jnc is_above | | <br>; execute code if A==data<br>; jump if A<data<br>; jump if A>data or exec. code | | |

*This paper was created by Št pán Mat jka alias Mates for anybody who needs it. Mates, Prague – Czech Republic 1998,2002.*

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B.Sc. in EEE, 7th Semester

December 13, 2022
10:00 am – 1:00 pm

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

Semester Final Examination
Course No.: EEE 4763
Course Title: Medical Electronics

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) Explain the process of skeletal muscle contraction inside a human body. **15 (CO1, PO1)**

   b) Explain how a power stroke happens in the muscle system. **10 (CO1, PO1)**

2. a) Illustrate how motion artifacts introduce noise in biopotential recording. Does ocular artifact affect EEG? Explain the reason. **8 (CO1, PO1)**

   b) Sketch the equivalent circuit of a piezoelectric sensor and identify different components with proper symbols. **5 (CO1, PO1)**

   c) A stimulus of short duration is presented to a human volunteer participating in a functional MRI experiment. Sketch a diagram showing the behavior of the following quantities from the time of the stimulus to the time when all quantities have returned to baseline: **12 (CO1, PO1)**

      i. CBF
      ii. CBV
      iii. $CMRO_2$
      iv. BOLD MRI signal

   Carefully match the timing of all curves.

3. a) Define half-cell potential. State the half-cell potential equation for an Ag/AgCl electrode showing how solubility product is related to the potential. **7 (CO1, PO1)**

   b) Sketch the electrical equivalent circuit model of an electrode-skin interface (electrolyte gel is present). **8 (CO1, PO1)**

   c) Calculate the maximal audio frequency of a Doppler ultrasonic blood flowmeter with a carrier frequency of 7 MHz, a transducer angle of $45^0$, a blood velocity of 150 cm/s and an acoustic velocity of 1500 m/s. **10 (CO2, PO2)**

or

   a) Define BOLD signal. How does CBF increase during activation? **7 (CO1, PO1)**

   b) List the differences between CBF and CBV. How are they related to transit time? **8 (CO1, PO1)**

c) An experiment is performed on a human subject to collect the BOLD MRI signal. The cerebral blood volume for the human subject is 4%. The volume of arterial blood transferred to a capillary bed in 1 second is .01 $mm^3$. Assume that the volume of tissue supplied by the capillary bed is a voxel of 1 $mm^3$. Calculate **10 (CO2, PO2)**

i. The fraction of the voxel volume being replaced with incoming arterial blood during this 1 second.

ii. The transit time for arterial blood through that capillary bed.

4. a) Define epilepsy. State the name of the medical imaging system that can detect epilepsy. How can we tip the magnetization to the transverse plane from the z-axis in the MRI system? **5 (CO1, PO1)**

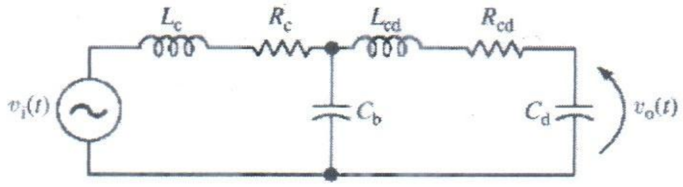
b) Explain the working principle of EMG. **10 (CO1, PO1)**

c) A 5 mm long air bubble has formed in the rigid-walled catheter connected to a sensor. The catheter is 1 m long, 6 cm in diameter and filled with water at 20° C (isothermal compression of air $\Delta V/\Delta P$ is 1 ml/1 cm of water pressure per litre of volume). Internal radius of the catheter is .46 mm; volume modulus of elasticity of the diaphragm is $.49 \times 10^{15}$ $N/m^5$; 1 cm of water pressure is 98.5 $N/m^2$. Calculate **10 (CO2, PO2)**

i. Natural frequency without the bubble

ii. Damping ratio without the bubble

iii. Total capacitance of the catheter-sensor analogous circuit given below. Here $C_d$ = diaphragm capacitance, $C_b$= bubble capacitance.




5. a) Write the basic components of an implantable device. State the use of automatic defibrillator in the clinical sector. **10 (CO1, PO1)**

b) State the working mechanism of digital X-ray. **10 (CO1, PO1)**

c) Distinguish between T2* and T2 decay. **5 (CO1, PO1)**

6. a) Identify the part of the k-space that contains most of the image information. Write the reason for producing repeated RF pulses for MRI? **5 (CO1, PO1)**

b) State the reason why B1 RF pulse is applied in the y axis. **5 (CO1, PO1)**

c) Show the timing diagram as accurately as possible for a spin-echo pulse sequence that collects a 45-degree angle k-space line with the $k_x$ and $k_y$ axes. Include **15 (CO1, PO1)**

i. RF pulses

ii. Gx

iii. Gy

iv. Gz gradients

v. Mxy, tip angle of each B1 RF pulse, TE and TR.

Carefully match the timing of all curves.

B.Sc.TE, 3rd Semester (2Yr)

December 13, 2022
10:00 am – 1:00 pm

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

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

Semester Final Examination
Course No.: EEE 4791
Course Title: Control System Engineering

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question are written in the brackets.

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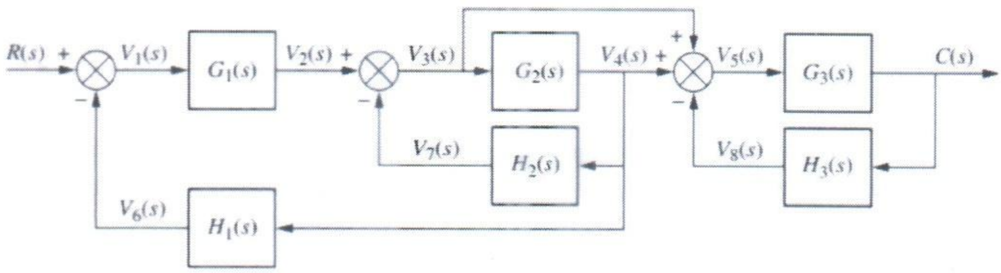
1. a) Explain with diagram the rules of reducing block diagram reduction **8**

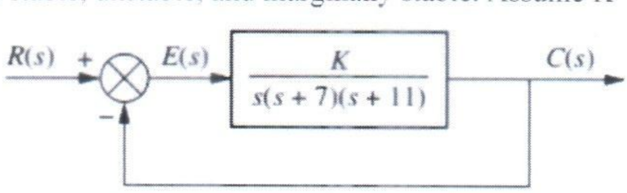
   b) Reduce the system shown in the following figure to a single transfer function. **17**




2. a) For the following transfer function, tell how many poles are in the right half-plane, in the left half-plane, and on the jω-axis. **15**

$$T(s) = \frac{20}{s^8 + s^7 + 12s^6 + 22s^5 + 39s^4 + 59s^3 + 48s^2 + 38s + 20}$$

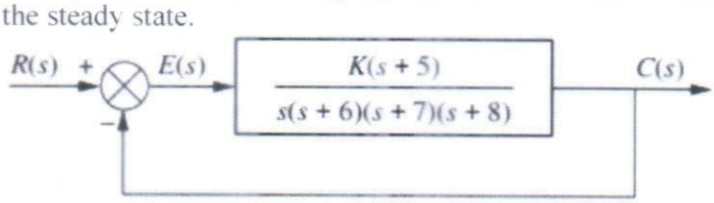
   b) Find the range of gain, K, for the system of that will cause the system to be stable, unstable, and marginally stable. Assume K > 0. **10**




3. a) Derive the equation for determining the steady-state in terms of G(s). Hence define static error constants and system type. **12**

   b) What information is contained in the specification Kp = 1000? **5**

   c) Given the control system in the following figure, find the value of K so that there is 10% error in the steady state. **8**

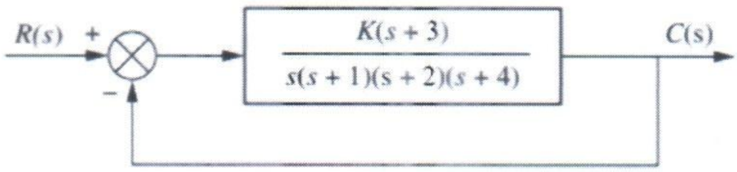


4. a) Briefly explain the properties of the root locus using suitable equations. **13**

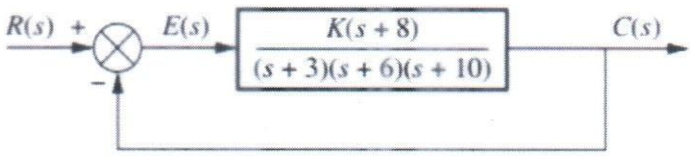
b) Find F(s) at the point s = -3 + j4. **12**

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

5. Sketch the root locus for the system shown in the following figure **25**




6. Given the system of the following figure, design a PID controller so that the system can operate with a peak time that is two-thirds that of the uncompensated system at 20% overshoot and with zero steady-state error for a step input. **25**



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M.Sc.TE, 1st Semester

December 15, 2022
10:00 am – 1:00 pm

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

Semester Final Examination
Course No.: EEE 6195
Course Title: Modern Control Theory

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **7 (seven)** questions. Answer any **6 (six)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question are written in the brackets.

---

1. a) Evaluate the steady-state error for the system described by following for unit step and unit ramp inputs. Use the final value theorem. **12**

$$\mathbf{A} = \begin{bmatrix} -5 & 1 & 0 \\ 0 & -2 & 1 \\ 20 & -10 & 1 \end{bmatrix}; \quad \mathbf{B} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}; \quad \mathbf{C} = \begin{bmatrix} -1 & 1 & 0 \end{bmatrix}$$

   b) Derive the following equation for determining steady-state error for a step input via input substitution. **13**

$$e(\infty) = 1 + CA^{-1}B\ .$$

2. a) Derive necessary formula to Systems represented in other forms to convert into phase variable form and applying pole placement topology and revert back to original system. **13**

   b) Determine whether the system is controllable. **12**

$$x = Ax + Bu = \begin{bmatrix} -1 & 1 & 2 \\ 0 & -1 & 5 \\ 0 & 3 & -4 \end{bmatrix} x + \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix} u$$

3. a) What is the challenge in designing controller for the system not represented in phase variable form? **12**

   b) Design a linear state-feedback controller to yield 20% overshoot and a settling time of 2 seconds for a plant **13**

$$G(s) = \frac{(s+6)}{(s+7)(s+8)(s+9)}$$

that is represented in state space in cascade form by

$$z = Az + Bu = \begin{bmatrix} -7 & 1 & 0 \\ 0 & -8 & 1 \\ 0 & 0 & -9 \end{bmatrix} z + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = Cz = \begin{bmatrix} -1 & 1 & 0 \end{bmatrix} z$$

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4. a) Explain with necessary diagram and formula different configuration of observer design. **13**

b) Design an observer for the plant **12**

$$G(s)=\frac{(s+6)}{(s+7)(s+8)(s+9)}$$

whose estimated plant is represented in state space in observer canonical form as

$$\hat{x} = A\hat{x} + Bu = \begin{bmatrix} -24 & 1 & 0 \\ -191 & 0 & 1 \\ -504 & 0 & 0 \end{bmatrix}\hat{x} + \begin{bmatrix} 0 \\ 1 \\ 6 \end{bmatrix}u$$

$$\hat{y} = C\hat{x} = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}\hat{x}$$

The observer will respond 10 times faster than the controlled loop design.

5. a) What is the downside of the determining controllability and observability by inspection? **12**

b) Determine whether the system **13**

$$x = Ax + Bu = \begin{bmatrix} -2 & -1 & -3 \\ 0 & -2 & 1 \\ -7 & -8 & -9 \end{bmatrix}x + \begin{bmatrix} 2 \\ 1 \\ 2 \end{bmatrix}u$$

$$y = Cx = \begin{bmatrix} 4 & 6 & 8 \end{bmatrix}x$$

is observable.

6. a) Derive necessary formulas related to alternative approaches to Observer Design. **12**

b) Design an observer for the plant **13**

$$G(s)=\frac{(s+6)}{(s+7)(s+8)(s+9)}$$

whose estimated plant is represented in state space in cascade form as

$$\hat{z} = A\hat{z} + Bu = \begin{bmatrix} -7 & 1 & 0 \\ 0 & -8 & 1 \\ 0 & 0 & -9 \end{bmatrix}\hat{z} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}u$$

$$\hat{y} = C\hat{z} = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}\hat{z}$$

The closed-loop step response of the observer is to have 10% overshoot with a 0.1 second settling time.

7. a) Steady-State Error Design via Integral Control. **12**

b) Design an integral controller for the plant **13**

$$x = \begin{bmatrix} 0 & 1 \\ -7 & -9 \end{bmatrix}x + \begin{bmatrix} 0 \\ 1 \end{bmatrix}u$$

$$y = \begin{bmatrix} 4 & 1 \end{bmatrix}x$$

to yield a step response with 10% overshoot, a peak time of 2 seconds, and zero steady-state error.

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M.Sc. TE. (2 yr), 1st Sem.

Date: December 09, 2022
10:00am – 01:00pm

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

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

Semester Final Examination
Course No.: EEE 6199
Course Title: Solid State Devices

Winter Semester, A.Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **8 (eight)** questions. Answer **any 6 (six)** questions. All questions carry equal marks. Marks in the margin indicate full marks. Do not write on this question paper.

---

1. a) Write short notes on Zener diode. 05

   b) With proper diagrams, discuss about the different types of resistance levels considered for *p-n* junction diode. 10

   c) With proper diagrams, discuss the Evaporation method and Sputtering method for thin film deposition. 10

2. a) How can you categorize semiconductor photodevices? What are the different categories? 05

   b) Sketch the *I-V* characteristics of a *p-n* junction solar cell. Define and explain short-circuit current, open circuit voltage, fill factor and efficiency of a solar cell with necessary equations. 10

   c) With neat diagrams, describe the construction and working principle of *p-i-n* photodiode. 10

3. a) Describe the difference between enhancement and depletion mode MOSFET. 05

   b) Briefly describe the p-well, n-well, and twin-tub process of cMOS fabrication. 12

   c) With proper schematic diagram, describe the oxidation process for growing oxide layer in solid-state device fabrication. 08

4. a) With neat diagrams, describe nMOSFET fabrication process in details. 15

   b) With suitable diagram, explain the body bias effect in an nMOSFET. 10

5. a) With diagram(s), derive the expressions of drain currents of an nMOSFET in linear and saturation regions of operation. 15

   b) Write down the definition and expression of transconductance, $g_m$ and output conductance, $g_{ds}$ of nMOSFET in linear and saturation region. 10

6. a) Consider an nMOS inverter with depletion type load. Supply voltage, $V_D = 5$ V. Threshold voltages of load and driver are $V_{td} = -4$ V and $V_{te} = 1$ V, respectively. Required low level output voltage is less than 30% of $V_{te}$. Let, $\varepsilon\mu/D$ for load and driver be 25 $\mu A/V^2$ and 30 $\mu A/V^2$, respectively. What will be the high-level output voltage? Calculate inverter ratio ignoring body effect of load. Choose suitable values of aspect ratios of load and driver network. 13

   b) Derive the equation of edge times of nMOS inverter with depletion type load. Follow the same transistor and circuit parameters as mentioned in Question 6(a). 12

7. a) Write some of the disadvantages of nMOS inverter with resistive load. 05

   b) Draw the circuit diagram of a cMOS inverter. Briefly explain its operating principle. 10

   c) Draw generalized $V_{out}$ versus $V_{in}$ and $I$ versus $V_{in}$ curves of a cMOS inverter. Label the axes with transistor and circuit parameters ($V_{tn}$, $V_{tp}$, $V_{dd}$, $I$). Also label different regions on the curves with the modes of operation of the load and driver transistors. 10

8. a) For a CMOS inverter circuit, describe the significance of inversion voltage. 05

   b) Draw the nMOS circuit design and cMOS circuit design for 3 input NAND gate. 08

   c) Draw the circuit diagram to implement the following Boolean expression using CMOS logic. 12

$$F = (AB + \bar{C})D$$

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M.Sc. Engg./ Ph.D. (EE) Date: December 15, 2022

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

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

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

Winter Semester, A.Y.2021-2022
Time: 3.0 Hours
Full Marks: 150

There are **8 (eight)** questions. Answer any **6 (six)**. All questions carry equal marks. Marks in the margin indicate full marks. All symbols carry their usual meanings.

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Q. 1. a) Explain the effects that could be captured by including the damper coils in the modeling of a synchronous machine. How does the number of damper coils play a vital role in mimicking different degree of machine dynamics? 08

b) The air gap permeance of a salient pole synchronous machine can be expressed as $P = P_{avg} + P_p\cos(2\theta_s)$. Could the value of $P_{avg}$ be zero? Justify your answer with a neat diagram. Also explain why does the permeance vary at a rate of $2\theta_s$. 06

c) The $P_{avg}$ and $P_p$ values of a salient pole synchronous machine are given as 2.5 and 1.4 Henries, respectively. Calculate the values of permeances along the d-axis ($P_d$) and q-axis ($P_q$) of the machine. Assume the number of turns in the coil to be 10. 06

d) The rotor inductance matrix of a salient pole synchronous machine is expressed as 05

$$\bar{L}_{rr} = \begin{bmatrix} L_{fdfd} & L_{fd1d} & 0 & 0 \\ L_{1dfd} & L_{1d1d} & 0 & 0 \\ 0 & 0 & L_{1q1q} & L_{1q2q} \\ 0 & 0 & L_{2q1q} & L_{2q2q} \end{bmatrix}.$$

Mention the reasons of zero entries in the matrix. Discuss on the necessity of applying Park's transformation to this matrix.

Q. 2. a) Prove that a choice of $k_1 = 2/3$ and $k_2 = 1/3$ for the Park's Transformation matrix will not yield a power-invariant transformation. 20

b) What is meant by fast-stator transients? Under what assumptions it could be excluded from the modeling. Explain in brief with appropriate equations. 05

Q. 3. a) The per-unit d-axis flux linkage expressions can be summarized as 12

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

Obtain the expressions of $I_{fd}$ and $I_{1d}$ in terms of $E_q^{/}$.

b) The algebraic relation between the terminal d-q axis voltage and the sub-transient d-q axis voltage is given as 08

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

$$E_q'' - e_q = R_s I_q \quad X_d'' I_d$$

Adopt necessary assumptions and obtain the corresponding equivalent circuit representation.

c) The relative magnitudes among different reactances in a salient pole synchronous machine can be represented as $X_d'' < X_d' < X_d$ and $X_q'' < X_q' < X_q$. Explain the reason for this variation. 05

Q. 4. Consider a synchronous generator supplying real power, $P_t$ = 1.0 p.u. and reactive power, $Q_t$ = 0.15 p.u. with terminal voltage $|V_t|$ = 1.05 p.u. The generator is connected to an infinite bus system having voltage $V_b$ through a transmission line having reactance $X_L$= 0.25 p.u. The machine parameters (in p.u except otherwise stated) are given in the following table. 25

| Parameter | Value | Parameter | Value |
|---|---|---|---|
| H | 4.0 | D | 0.0 |
| $X_d$ | 2.0 | $X_q$ | 1.8 |
| $X_d'$ | 1.0 | $T_{do}'$ | 4 sec. |
| f | 50 hz. | | |

Calculate the initial values of the system variables and construct the corresponding phasor diagram.

Q. 5. a) The dynamic model of a single machine infinite bus system is expressed as: 10

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

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

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

where,

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

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

Obtain the expressions of linearizing constants $K_1 - K_4$ for the system.

b) A fast acting voltage regulator system is modeled by the block diagram of figure 5(b). Obtain the expressions of the linearizing constants $K_5$ and $K_6$. 05

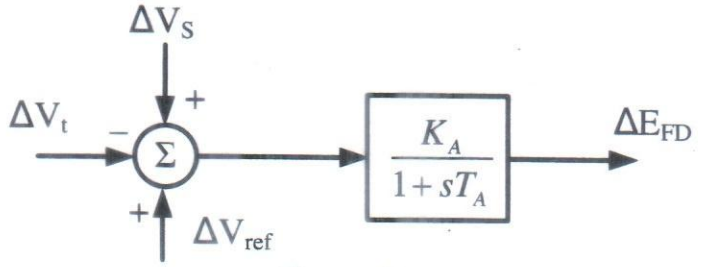


Figure 5(b)

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c) Explain how the static excitation system eliminates the need of rotating components. 05

d) How does the introduction of high-gain excitation system deteriorate the performance of power system? Discuss in short. 05

Q. 6. a) Discuss in brief the three important functions of an excitation system of a synchronous machine. 06

b) Discuss the purpose of voltage regulator, load compensation, and voltage transducer of an excitation system. 06

c) Figure 6(c) depicts the IEEE type DC1A Excitation system block diagram. Obtain the corresponding differential equation model of the system and find out the steady state expressions of the state variables. 13

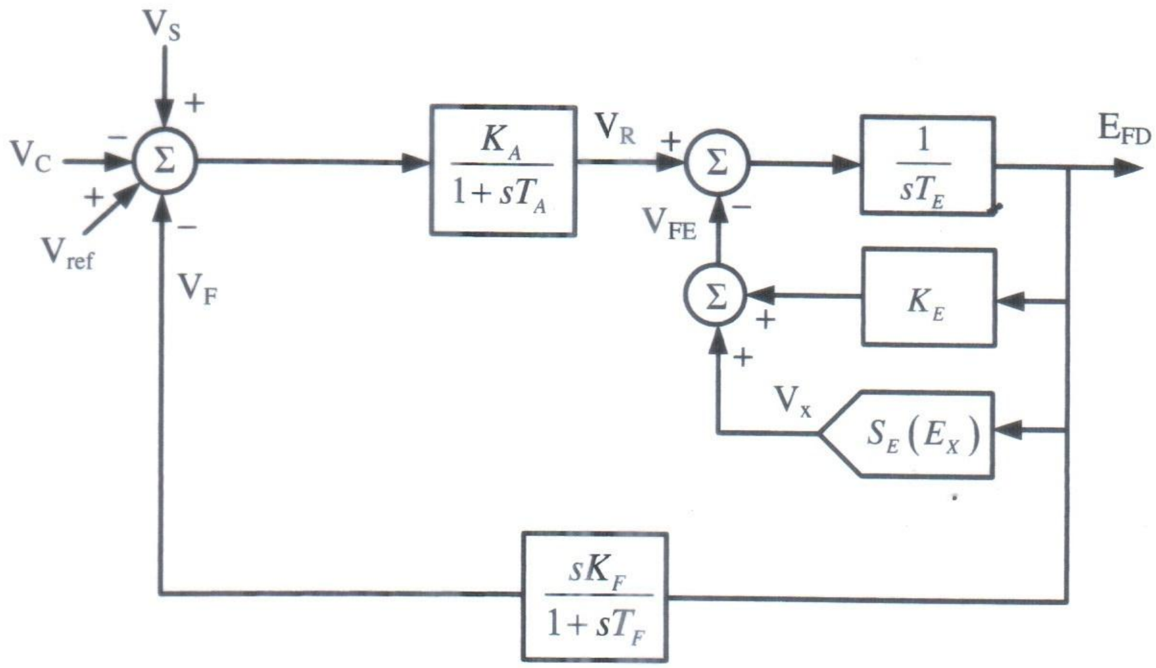


Figure 6(c)

Q. 7. a) The following dataset is provided for the design purpose of a speed-input based power system stabilizer (PSS). 20

| Parameter | Value | Parameter | Value |
|---|---|---|---|
| H | 6.0 | D | 0.0 |
| $X_d$ | 1.5 | $X_q$ | 1.0 |
| $X_d'$ | 0.35 | $T_{do}'$ | 5 sec. |
| f | 50 Hz. | | |
| $K_1$ | 1.5687 | $K_2$ | 1.5560 |
| $K_3$ | 0.3429 | $K_4$ | 1.7894 |
| $K_5$ | -0.1388 | $K_6$ | 0.3059 |
| $K_A$ | 30 | $T_A$ | 0.2 sec. |
| $T_w$ | 5 sec. | | |

Assuming reasonable value of $T_2$, design a PSS using phase-compensation method if the desired level of damping is 0.25.

b) Discuss in short the different types of low frequency oscillation modes experienced by a power system. 05

Q. 8. a) The simplified dynamics of a hydro turbine can be represented as $T_W \frac{d\Delta\overline{P}_m}{dt} = 2\left\{-\Delta\overline{P}_m + \Delta\overline{G} - T_W \frac{d\Delta\overline{G}}{dt}\right\}$. Is it possible to represent this dynamics in state-space form? Justify your answer. 05

b) What is meant by 'droop' in a speed-governor operation? Differentiate between isochronous and non-isochronous speed governing mechanisms. 05

c) Explain the working principle of the hydraulic amplifier in a watt-governor system. 05

d) How does the surge tank assist in controlling the pressure through the penstock of a hydro-power generation system? 05

e) Suppose a-b-c is a rigid rod pivoted at the intermediate point 'b', where point 'a' is connected to the speed changer setting of the governor and point 'b' is connected to a flyball speed sensing mechanism. Derive the expression of the total displacement of point 'c' due to the movements of point 'a' and 'b'. 05

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M.Sc. TE, 3rd Semester

Date: December 07, 2022
Time: 10.00 AM– 1.00 PM

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

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

Semester Final Examination
Course No.: EEE 6393
Course Title: Energy Conversion

Winter Semester, A.Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **8** questions. Answer **any 6** of them. All questions carry equal marks. Marks in the margin indicate full marks. Programmable calculators are not allowed. Symbols preserve their usual meaning.

1. a) Describe the law of conservation of energy. What do you understand by 'transitional energy' and 'stored energy'? Explain with necessary description and examples. 15

   b) Draw the characteristics curve (I-V and P-V) of solar cell and explain it briefly. What is maximum power point and fill factor? 10

2. a) What is blocking diode? Explain with diagram. Explain the major advantages and disadvantages of Amorphous Si Solar panels. 15

   b) Draw the structure of a solar cell and briefly explain different parts of it. What are the primary steps for designing an off-grid PV system? 10

3. a) What do you understand by 'conventional' and 'non-conventional' energy? Describe them briefly. Explain the concept of 'parabolic trough technology' and 'solar dish engine'. 15

   b) Define the following things from the concept of solar thermal conversion: 10
      i. Non concentrating collector,
      ii. Concentration to a line,
      iii. Point focusing.

4. a) How can you calculate the power of wind energy? What are the components of wind turbine? Draw a simple diagram and locate the components. 15

   b) What is Betz's law? Write down necessary equations and briefly explain it. 10

5. a) What is biomass energy? What are the sources of biomass energy? Describe the concept of biopower by drawing a biopower integrated system. 15

   b) What is biofuel? Describe the process of ethanol production by drawing a flow diagram. 10

6. a) What is tidal energy? Explain the concept of 'la range barrage' with appropriate diagram. 15

   b) What are the types of wave energy devices? Describe the concept of 'TAPCHAN'. 10

7. a) What is fuel cell? State the working principle of fuel cell. Describe alkaline fuel cell and phosphoric acid fuel cell with proper diagram. 15

b) Explain the major advantages and disadvantages of geothermal energy? 10

8. a) Explain the following terms: 25

i. Direct use of geothermal energy,
ii. Ocean thermal energy conversion,
iii. Thin film solar panels,
iv. EVA film,
v. Hot spot phenomenon and bypass diode.

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M.Sc. Engg./ Ph.D (EE) Date: 05 December, 2022

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

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

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

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

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) Though the linewidth of the individual laser has not becomes pure, the photodetected signal in a side frequency injection locking scheme becomes spectrally pure. Justify the above statement with detail analysis. 10

   b) Discuss various schemes of optical transmission of mm-wave signals. 10

   c) Derive the relation that gives the steady-state electron density in the active region of an LED. 10

   d) Discuss optical gain characteristic of a LASER. 10

   e) Assuming the responsivity of the PD as 0.8 A/W and average photocurrent is 0.2 mA of a heterodyning system. Calculate the optical power of each laser. 10

2. a) Explain the operation principle of an EDFA. 10

   b) Draw a schematic diagram of WDM and DWDM light-wave system. What is the important feature of WDM? 10

   c) Derive the noise figure of an optical amplifier. 10

   d) Explain the operation principle of a Raman amplifier. 10

   e) Discuss the operation principle of a laser and a p-n photodiode. 10

3. a) Prove that the BER is minimum when the decision threshold is set close to a value given by $I_D = \dfrac{\sigma_0 I_1 + \sigma_1 I_0}{\sigma_0 + \sigma_1}$ 10

   b) Consider a photonic link with parameters as follows: the average photocurrent, $I_{av}$, is 2.4 mA and the responsivity of the photodetector is 0.75 A/W. Assume a typical laser RIN value of -155 dB/Hz. The thermal noise contribution from the photodetector matching resistor is independent of the optical power and amounts to -174 dBm/Hz, at room temperature (T = 290 K). 10

      (i) Calculate the shot noise, thermal noise and relative intensity noise powers (in 1 Hz bandwidth).
      (ii) Comment on the dominating noise term in this photonic link.

c) Write various methods to fabricate optical fiber. Discuss Double crucible method for fiber fabrication. 10

d) Draw the energy band diagram for heterostructure p-n junction. 10

e) What are the advantages of p-n photodiode over p-i-n photodiode? 10

4. Discuss the following: 50
   (i) MZM.
   (ii) DFB laser.
   (iii) Optical injection locking.
   (iv) Optical heterodyning.

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

**Date:** 13 December, 2022
**Time:** 10:00 am – 1:00 pm

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

Semester Final Examination
Course No.: EEE 6403
Course Title: Wireless Communication

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **8 (eight)** questions. Answer **any 6 (six)** 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) If we use 200 GHz carrier frequency, instead of the current use of lower frequencies, determine the additional advantages and the additional disadvantages that will be obtained. 10

   b) Consider Friis free space between the transmitter and the receiver. The transmit power is 10 watt. At the distance of 2 km from the transmitter, the received power is 10 milliwatt. If the transmit power is increased to 20 watt, what will be the received power at the distance of 4 km from the transmitter? 15

2. a) Assume that a cellular operator has deployed 5G cellular communication with wide bandwidth in a few villages in Bangladesh. However, the villagers do not experience a good data rate. Determine the possible reasons for the poor data rate. 7

   b) Explain Superposition Coding (SC) for the case of Non-Orthogonal Multiple Access (NOMA). 8

   c) How does Reverse Tunneling take place in the case of Mobile IP? Explain Triangular optimization. 10

3. a) Write down the functions of HLen and Checksum of IP header. How many bits are used in the IP address for IPv4 and IPv6. Why is a longer address introduced in IPv6? 13

   b) A 4000 bytes long IP packet is split into 4 equal segments. The IDENT field of the third segment has value 8. Determine the values of IDENT field and OFFSET field for the fourth segment. 12

4. a) How does TCP detect whether or not a duplicate packet has arrived? Explain fast retransmit and slow start procedures. 13

   b) Assume that all bytes are sequentially numbered in TCP buffers. The buffer on the receiving side can accommodate 1024 bytes. The congestion window size is 512 bytes. The sequence numbers of other parameters for the buffers are as follows. 12

   LastByteRead = 394, NextByteExpected = 765
   LastByteSent = 1034, LastByteAcked = 880

   Determine the maximum window size for transmission.

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5. a) Why does TCP need a special technique when there is a wireless link? 10

b) Explain Indirect TCP (I-TCP), Snoop Protocol, and Mobile TCP (M-TCP). 15

6. a) In a cellular environment, there are different users in different states. Some users are located close to the base station while some are located far away near the cell boundary. Some users are not moving, some are moving at low velocity and some are moving very fast. The following MIMO options are available. Discuss the suitability of different MIMO options for different types of users and give reasons. 13

   i. Open Loop Transmit Diversity
   ii. Closed Loop Transmit Diversity
   iii. Open Loop Spatial Multiplexing
   iv. Closed Loop Spatial Multiplexing
   v. Multi-User MIMO

b) Derive the expression that needs to be zero for Zero-Forcing Beamforming (ZFBF) in Multi-User MIMO. 12

7. a) Define look angles and sub-satellite point for the satellite. 10

b) A satellite in an elliptical orbit around the earth has an apogee of 39,152 km and a perigee of 500 km. What is the orbital period of this satellite? 15

(The average radius of the earth is 6378.137 km and Kepler's constant has the value 3.986 004 418 $\times$ $10^5$ $km^3/sec^2$).

8. a) Define Adhoc Network. Explain the purpose of short tinter frame space (SIFS). 10

b) There are five terminals A, B, C, D, and E in a local wireless network. Request-to-Send (RTS) and Clear-to-Send (CTS) are not used in this network. For any of the terminals, the coverage area is circular with the terminal placed at the center. The locations of the terminals with respect to their coverage areas are shown in Figure 1. C sends data to D. Determine the terminals between which Hidden Terminal Problems and Exposed Terminal Problems may occur. 15

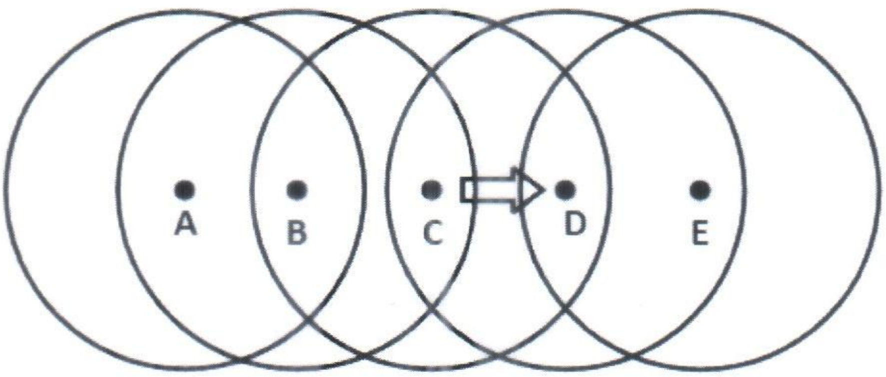


Figure 1

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M.Sc. Engg./ Ph.D.

December 09, 2022
10:00 am – 1:00 pm

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

Semester Final Examination
Course No.: EEE 6413
Course Title: Engineering Optimization

Winter Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **8 (eight)** questions. Answer any **6 (six)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question are written in the brackets.

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1. a) State Kuhn-Tucker Conditions. **5**

   b) Maximize the following objective function subjected to the given constraints by applying Kuhn-Tucker conditions. **20**

$$Maximize\ f = 8x_1 + 4x_2 + x_1x_2 - x_1^2 - x_2^2$$

Subject to

$$2x_1 + 3x_2 \leq 24$$
$$-5x_1 + 12x_2 \leq 24$$
$$x_2 \leq 5$$

2. a) State the standard form of a Linear Programming Problem both in scalar and matrix form. **5**

   b) A manufacturing firm produces two machine parts using lathes, milling machines, and grinding machines. The different machining times required for each part, the machining times available on different machines, and the profit on each machine part are given in the following table. **5**

| Type of machine | Machining time required (min) | | Maximum time available per week (min) |
|---|---|---|---|
| | Machine part I | Machine part II | |
| Lathes | 10 | 5 | 2500 |
| Milling machines | 4 | 10 | 2000 |
| Grinding machines | 1 | 1.5 | 450 |
| Profit per unit | $50 | $100 | |

   Write the objective function and the constrains of the stated problem.

   c) Find all the basic solutions corresponding to the system of equations and identify whether solutions are feasible or not, optimal or not and degenerative or not. **15**

$$2x_1 + 3x_2 - 2x_3 - 7x_4 = 1$$
$$x_1 + x_2 + x_3 + 3x_4 = 6$$
$$x_1 - x_2 + x_3 + 5x_4 = 4$$

3. a) Solve the following linear programming problem using simplex method. **20**

$$Maximize\ f = x_1 + 2x_2 + x_3$$

Subject to

$$2x_1 + x_2 - x_3 \leq 2$$
$$-2x_1 + x_2 - 5x_3 \geq -6$$
$$4x_1 + x_2 + x_3 \leq 6$$
$$x_i \geq 0, \quad i = 1, 2, 3$$

b) Mention the conditions that will lead a linear programming problem to have unbounded solution and infinite number of solutions. **5**

4. a) Define a unimodal and multimodal function with suitable diagram. **5**

b) Find the value of x in the interval (0, 1) which minimizes the function $f = x(x - 1.5)$ to within $\pm 0.05$ by (i) the golden section method and (ii) the Fibonacci method. **20**

5. Find the minimum of the function $f = \lambda / \log \lambda$ by (i) the Newton method and (ii) the secant method. **25**

6. Minimize $f = 2x_1^2 + x_2^2$ from the starting point (1, 2) using univariate method (Three iterations only) **25**

7. a) Minimize $f = 4x_1^2 + 3x_2^2 - 5x_1x_2 - 8x_1$ by using the steepest descent method with the starting point (0, 0) (three iterations only) **20**

b) What is the modification of steepest descent that leads to Fletcher-Reeves method and mention its advantage. **5**

8. a) Show that the Newton's method finds the minimum of a quadratic function in one iteration. **10**

b) Minimize $f = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ by taking the starting point (0, 0) using Newton's method. **15**