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Name of the Program: B. Sc. in EEE
Semester: 2nd Semester

Date: March 29, 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 4201
Course Title: Electrical Circuit II

Summer Semester, A.Y. 2020 – 2021
Time: 3 Hours
Full Marks: 150

There are **3 (three)** questions. Answer all **3 (three)** questions. The symbols have their usual meanings. Marks of each question and corresponding COs and POs are written in the brackets. 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) Explain singularity function in the light of circuit operations and mathematical operations. $(5 \times 6 = 30)$ (CO1) (PO1)

   b) Exemplify the comparative analysis between source-free response and step response of an RLC series circuit.

   c) Locate the set of information obtained from the placement of power triangle in different quadrants in a Cartesian plane.

   d) Illustrate the meaning of damping in terms of passive elements of a DC circuit.

   e) Interpret the quality factor and bandwidth of a resonant circuit. Explain their codependence with appropriate diagrams and expressions.

   f) Formulate a passive bandstop filter and explore different salient aspects of this filter.

2. a) Deduce and sketch the step response of an RL circuit. $(5 \times 6 = 30)$ (CO2) (PO2)

   b) Summarize the concept of duality and its applicability for electrical circuits in linking parallelism between similar circuits.

   c) Evaluate the significance of shifting or scaling property of a unit impulse applied to a practical dc circuit with proper reasoning.

   d) Interpret the states of different circuit parameters of an electrical circuit under resonance.

   e) Assess all the possible balanced $3-\varphi$ systems and recommend the best one of these with proper justification.

   f) Justify the formation of the negative regions on the graph of the instantaneous power, $p(t)$, based on the offset value of $p(t)$.

3. a) Solve for the voltage, $v(t)$ of a circuit described by the integrodifferential equation: (05) (CO3) (PO3)

$$\frac{d^2v}{dt^2} + 2\frac{dv}{dt} - 10\int v\,dt + 5v = 50\sin(5t - 30^0)$$

b) For the mutually inductive circuit in Fig. 3(b), solve for the equivalent inductance between the terminals a – b. The arrow indicates the direction of current flow. (05) (CO3) (PO3)

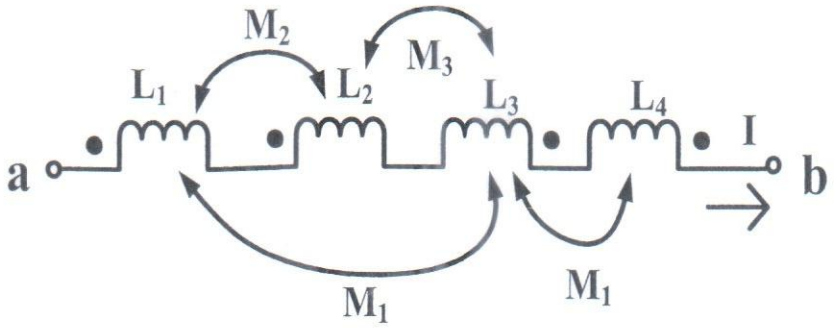

Fig. 3(b)

c) Solve for $i(t)$ depicted in Fig. 3(c) in terms of singularity functions only. (05) (CO3) (PO3)

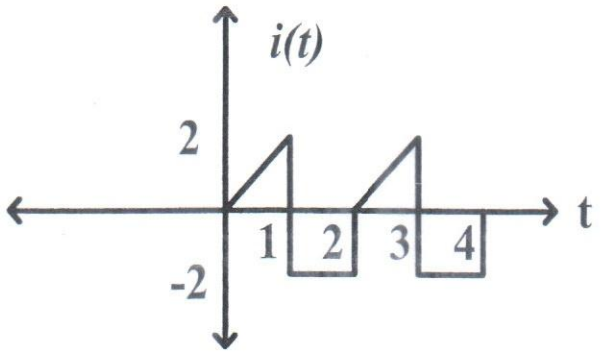

Fig. 3(c)

d) Formulate the mesh equations for the circuit in Fig. 3(d). (05) (CO3) (PO3)

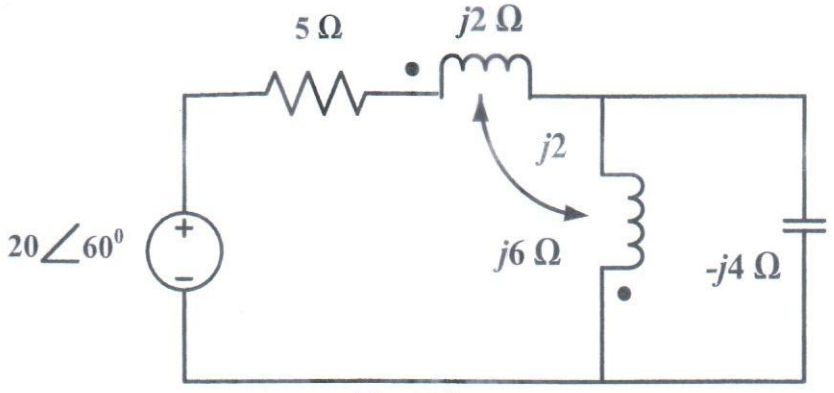

Fig. 3(d)

e) Solve for the dual parameters of the circuit in Fig. 6 and sketch the dual circuit. (05) (CO3) (PO3)

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4. a) Deduce the node equations and solve for the current I_o for the circuit in Fig. 4(a). (15) (CO3) (PO3)

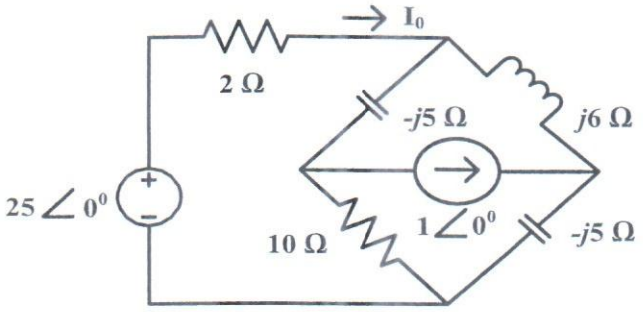

Fig. 4(a)

b) The switch for the circuit in Fig. 4(b) is closed at $t = 0$. Find $i(t)$ and $v(t)$ for all time. (15) (CO3) (PO3)

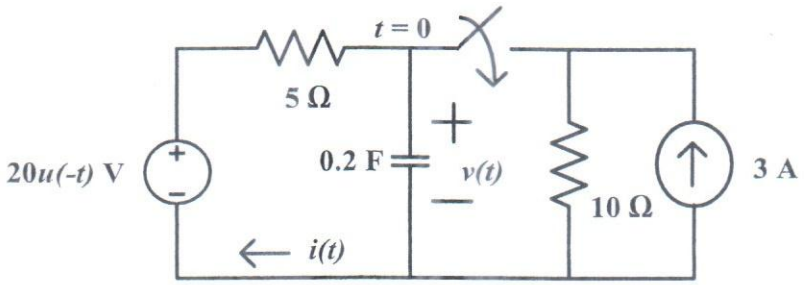

Fig. 4(b)

5. For the circuit in Fig. 5, solve and sketch the waveshape for $v(t)$. (15) (CO3) (PO3)

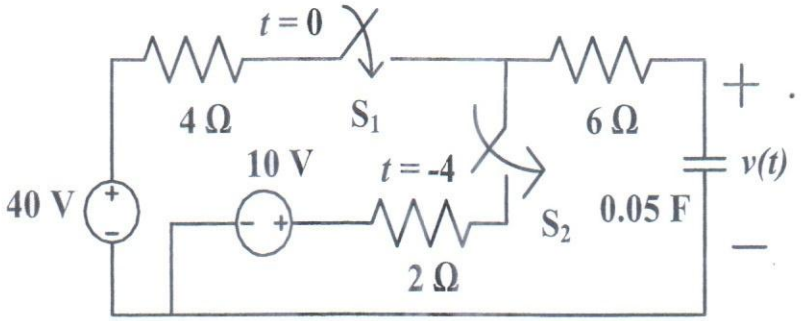

Fig. 5

6. For the circuit in Fig. 6, solve for: $i(0^+)$, $v(0^+)$, $v_R(0^+)$, $i(\infty)$, $v(\infty)$, $v_R(\infty)$, $\frac{di(0^+)}{dt}$, $\frac{dv(0^+)}{dt}$ and $\frac{dv_R(0^+)}{dt}$. (20) (CO3) (PO3)

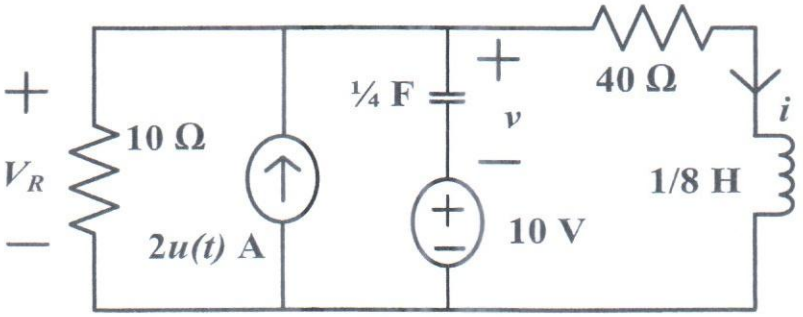

Fig. 6

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B.Sc. Engg. (EE)
2nd Semester

Date: April 7, 2022
Time: 10.00 AM - 1.00 PM

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

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: EEE 4203
Course Title: Electronics I

Summer Semester, A.Y. 2020-2021
Time: 3 Hours
Full Marks: 150

Answer **all 6 (Six)** questions. Note that two questions (3 and 8) have options. Programmable calculators are not allowed. Figures in the margin indicate marks of the part questions. Do not write on this question paper. Assume reasonable value for any missing data. (Graph paper will be supplied)

1(a) Find V_O and I for the circuit shown in the following figure. v_I is a 1 kHz, 10-V peak sine wave, sketch the wave form resulting at v_o. What are its positive and negative peak values? Diodes are ideal. [09] CO1 PO3

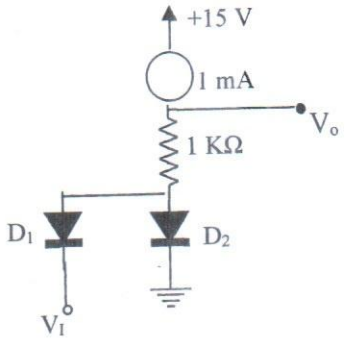

Fig.1(a)

(b) For the following circuit, a string of three diodes are used to provide a constant voltage of about 2.1 volt. Calculate percentage of change in this regulated voltage caused by [10] CO1 PO3
(i) ±10% change in power-supply
(ii) connection of R_L=500 Ω load resistance. Assume n=2.

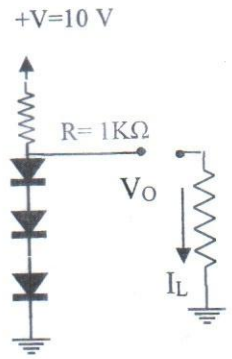

Fig.1(b)

(c) Draw the circuit diagram of an AND gate using ideal diodes and describe how AND logic operation is performed in the circuit. 06 CO1 PO3

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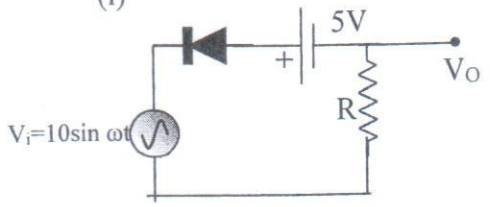
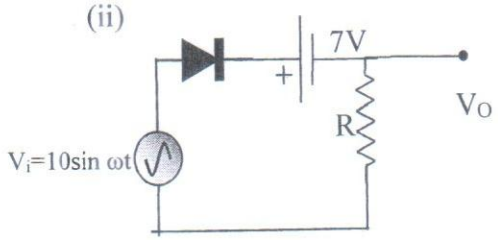
2.(a) Find the output wave-shapes for the following clippers (diodes are ideal): [12] CO4 PO3

(i)

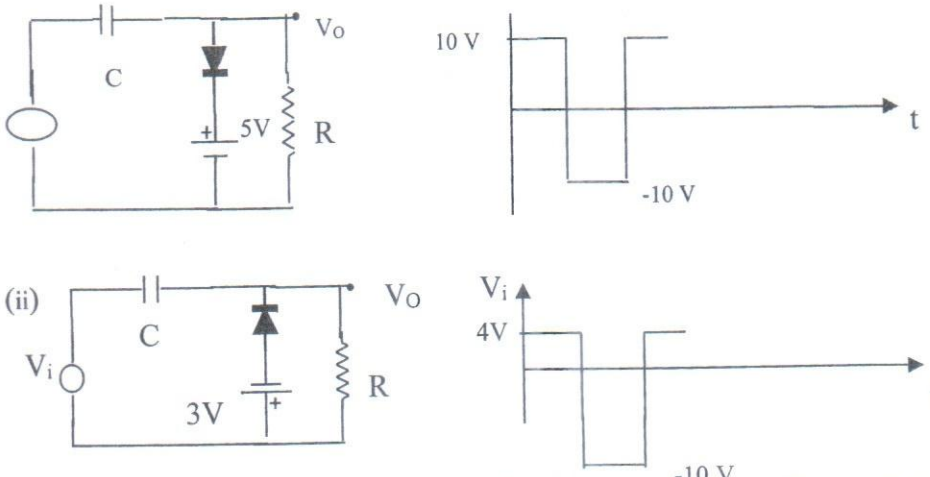


(ii)



(b) Find the output wave-shapes for the following clampers (diodes are ideal): [13] CO4 PO3

(i)



(ii)

3. (a) Design a 7.5 V zener regulator circuit using 7.5 V zener specified at 12 mA. The zener has an incremental resistance r_z=30 Ω and a knee current of 0.5 mA. The regulator operates from a 10 V supply and has 1.2 k Ω load. Design the value of R (you may assume any current through it but zener should be in the breakdown). Find the output voltage with no load conditions. What is the smallest possible load resistor that can be used while the zener operates at a current no lower than the knee current while the supply is 10% low? 13 CO4 PO3

(b) Draw the waveshape of the output voltage v_o of the following rectifier circuit and find the average value of the output voltage. 12 CO1 PO3

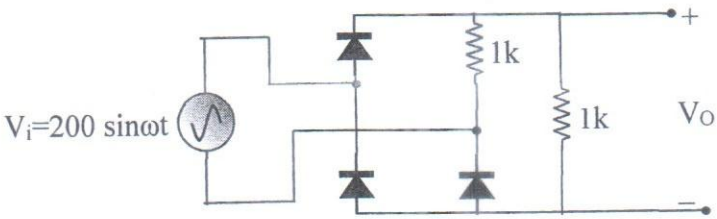


Fig.3(a)

OR

3. (a) Using the fact that a silicon diode has I_S=10^{-14} A at 25°C and I_S increases by 15% per °C rise in temperature, find the value of I_S at 125°C. 05 CO3 PO3

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(b) Using the diode equation in forward biasing region, find the expression of small signal resistance of a diode. What is the sigficance of this reisitance if the diode is used as a voltage regulator? 08 CO2 PO3

(c) Determine the range of R_L and I_L that will result in load voltage being maintained at 10 V (assume r_Z=0) for the following circuit shown the Fig 12 CO2 PO3

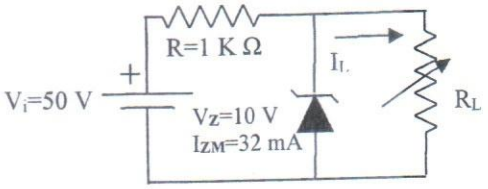


Fig.3(c)

4.(a) For the following circuit, find the highest voltage to which the base can be raised while the transistor remains in the active mode. Assume α=1. [08] CO1 PO3

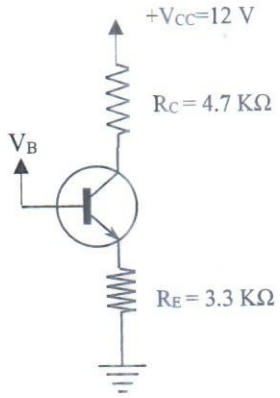
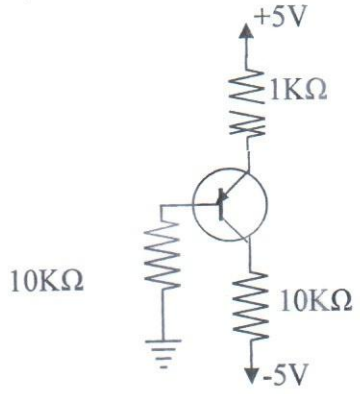


Fig.4(a)

b) For the following circuit determine whether the BJT is in active or saturation mode. Then determine V_E, V_C, V_B, I_E,, I_C and I_B. [12] CO1 PO3



β_{min}=30

Fig.4(b)

c) What is the sigficance of Q point in a BJT amplifier? Does its location affect the performance of the amplifier? [05] CO1 PO3

5.(a) Draw a common emitter amplifier circuit. Draw its small signal equivalent circuit and find the expressions of (i) R_{in} (ii) A_v (iii) G_v (iv) A_{is} and (v) R_O. [15] CO1

(b) For the above amplifier of Q. 4(a), R_B=100 kΩ, R_C=8 kΩ, R_L=5 kΩ, g_m=40 mA/v, r_π=2.5 kΩ, r_o=100 kΩ, r_e=25 Ω. If R_{sig}= 5 k Ω and the sine-wave v_π is limited to 5 mV peak, what is the maximum allowed peak of v_{sig} and the corresponding peak amplitude of v_o. [10] PO3 CO3 PO3

6.(a) Describe the differences between BJTs and FETs. Why JFETs are widely used in digital ICs? [05] CO2 PO2

(b) Describe the operation principle of a depletion type n-channel JFETs with proper diagrams including semiconductor structure and output characteristics. How can a JFET be used as a variable resistor? [10] CO2 PO2

(c) Given I_{DSS} = 6 mA and V_P = - 4.5 V; Using Shockley's equation draw the transfer characteristics of a deletion type n-channel MOSFET. If V_{GS} is positive which region it will operate? What precaution has to be taken to have a positive gate to source voltage? [10] CO2 PO2

OR

6. (a) Determine V_D for the following network shown in Fig. 6(a). [12] CO2 PO2

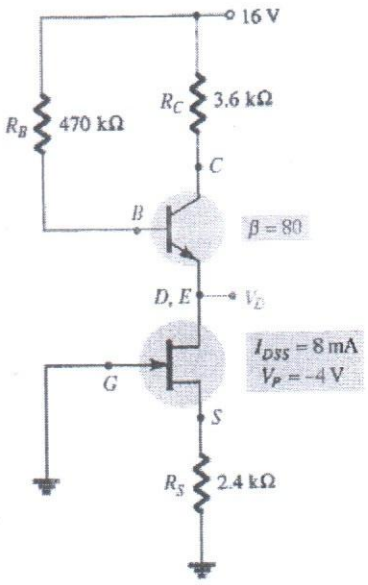


Fig. 6(a)

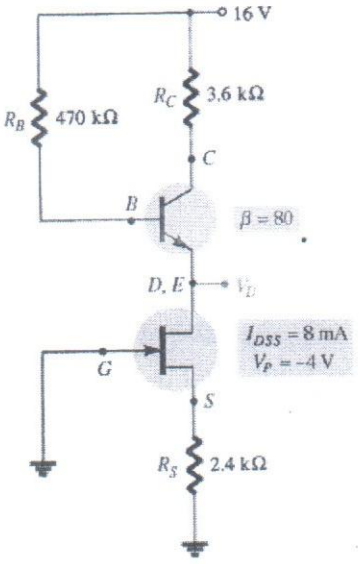


Fig. 6(b)

(b) Determine (i) I_{DQ} (ii) V_{SQ} and V_{DQ} (iii) V_{DS} for the network of Fig. 6(b). [13] CO2 PO2

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B. Sc. in EEE/TVE (2nd Year)
2nd Semester

Date: 12 April, 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: Math 4221/Math 4629
Course Title: Mathematics III

Summer Semester : 2020 - 2021
Full Marks: 150
Time : 3.0 Hours

There are **06 (six)** questions. Answer **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) Explain the physical significance of the divergence and curl of a vector. **(12) (CO1) (PO1)**

   (b) Evaluate $\int_C \vec{F}.d\vec{r}$ where C is the closed curve formed by $y=2x^2$ and $y^2=32x$ and $\mathbf{F}=(2x+y^2)i+(3y-4x)j$. **(13) (CO1) (PO1)**

2. (a) State and prove Green's theorem in the plane. **(12) (CO2) (PO2)**

   (b) Differentiate $f(z)=z^2-iz$ along the straight line parallel to $y=x$ **(13) (CO2) (PO2)**

3. (a) Obtain the formula to solve the equation $z^n=z_0$. Use this formula to find the roots of $z^8 = -16\sqrt{3} - 16i$ and locate them graphically. **(12) (CO1) (PO1)**

   (b) Determine the region of the w plane into which the interior of the triangle x=1, y=1 and y= -2x+1 is mapped by the transformation $w= 5e^{\frac{i\pi}{3}} z - 2 + 4i$ **(13) (CO2) (PO2)**

4. (a) Derive Cauchy Riemann equations and find the polar form. **(12) (CO1) (PO1)**

   (b) Find the Taylor series expansion for the function $f(z)=\text{cosec}^2 z$ about $z = \frac{\pi}{2}$. **(13) (CO2) (PO2)**

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5. (a) State Cauchy's residue theorem. Find the residue of $f(z)= (z^2-2z)/(z^2+4)^3$ at all poles and hence evaluate the integral $\int_C f(z)dz$ where C is the circle $|z-i|=2$ **(12) (CO1) (PO1)**

(b) From the following data find X when Y=6 **(13) (CO3) (PO12)**

X	2.3	2.5	3.9	3.6	4.1	3.2	1.4	1.1
Y	8.6	8.1	7.6	7.8	7.4	6.6	5.2	6.1

6. (a) Explain Binomial distribution and Poisson's distribution. **(12) (CO3) (PO12)**
Fifteen percent of the tools produced in a certain manufacturing process turn out to be defective. Find the probability that in a sample of 12 tools chosen at random (i) more than ten (ii) at least two will be defective by using Poisson's distribution.

(b) Find the area bounded by the normal curve and the horizontal axis. **(13) (CO3) (PO12)**
A manufacturer knows from experience that the resistance of resistors is normally distributed with mean 100 ohms and standard deviation 2 ohms. What percentage of resistors will have resistance between 99 ohms and 103 ohms?

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B. Sc. in EEE
2nd semester

15 April, 2022
Time: 10:0 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 4221
Course Title: Engineering Physics II

Summer Semester: 2020 - 2021
Full Marks: 150
Time: 3 Hours

There are **8 (Eight)** questions. Answer **6 (Six)** questions according to the instructions mentioned in Sec A and Sec B. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

Sec A
Q1 is compulsory. Answer any Two questions from the rest.

1. (a) Discuss classification of solids from the crystallographic point of view. [6+13+6]
(b) Distinguish between cubic and hexagonal crystal systems. Sketch all Bravais lattices in these crystal systems and calculate number of atoms per unit cells for these Bravais lattices. Formulate relationships between atomic radii and lattice parameters for these crystal systems. (CO 1, CO 2, CO 3) (PO 1, PO 2, PO 3)
(c) Evaluate c/a ration for hexagonal crystal system.

2. (a) Briefly analyze the statement 'Real crystals are never perfect'. [6+13+6]
(b) Describe the classification of defects observed in solids. (CO 2, CO 3, CO 4)
(c) Consider the energy required to create a vacancy in copper crystal is 0.9 eV and the density of copper is 8960 kgm^{-3}. Evaluate the equilibrium number of vacancies in 1 m^3 copper crystal at 1050 °C. (PO 2, PO 3, PO 4)

3. (a) Discuss the characteristics of simple harmonic motion. Write an equation of simple harmonic motion and explain each term on it. Sketch displacement, velocity and acceleration as a function of time for a particle executing simple harmonic motion. Evaluate the total mechanical energy of a linear oscillator and illustrate that it is independent of time and position of the oscillator [16+9] (CO 2, CO 3, CO 4) (PO 2, PO 3, PO 4)
(b) Sketch the followings:
(i) Two simple harmonic motion having same frequency and period but different amplitudes, (ii) Two simple harmonic motion having same

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amplitudes but different frequency (iii) Two simple harmonic motion having same amplitude and frequency but different phases.

(c) Starting from the displacement of a simple harmonic motion

4. (a) Explain the term Lissajous figures. Evaluate the resultant of two mutually perpendicular simple harmonic motion of equal frequency, differing amplitude and pahse. [16+9] (CO 2, CO 3, CO 4) (PO 2, PO 3, PO 4)

(b) Formulate the differential equation of forced vibration with damping. Develop the steady state solution of this vibration. Illustrate amplitude and phase of this vibration as a function of frequency.

Sec B

Question 5 and 6 are compulsory. Answer any one from questions 7 and 8.

5. (a) Write down the postulates of the special theory of relativity. 05 CO-5 PO-5

(b) What is relativistic mass? Deduce Einstein's mass energy relation considering relativistic effect. 15 CO-6 PO-6

(c) What is length contraction? A crew member on a spaceship that flies past at a speed of 0.98c relative to the earth, measures its length obtaining 300 m. What length the observer will measure on earth? 05 CO-6 PO-6

6. (a) What is a thermocouple? Draw schematically the standard configuration of a Chromel–alumel thermocouple. 08 CO-7 PO-7

(b) How can Thomson effect provide a link between Seebeck effect and Peltier effect? What are positive, negative and zero Thomson effect? 08 CO-7 PO-7

(c) What is the significance of neutral temperature and inversion temperature for a thermocouple? Explain Seebeck and Peltier effect using free electron theory. 09 CO-7 PO-7

7. (a) Describe briefly different types of waves with appropriate examples. 10 CO-8 PO-8

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(b) Draw schematically the potential energy, kinetic energy, and mechanical energy as a function of time for a linear harmonic oscillator. At which position energy is all kinetic and at which position it is all potential? 10 CO-8 PO-8

(c) Find the mechanical energy of a block–spring system having a spring constant of 1.3 N/cm and an oscillation amplitude of 2.4 cm. 05 CO-8 PO-8

8. (a) Distinguish between transverse and longitudinal waves? 05 CO-8 PO-8

(b) How can you prove that the wave speed is one wavelength per period? 05 CO-8 PO-8

(c) Show that the average power of a wave depends on the square of its amplitude and also on the square of its angular frequency. 15 CO-8 PO-8

66 B.Sc. Engg. (CEE)/ 2nd Sem. 13th April, 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

SEMESTER FINAL EXAMINATION — SUMMER SEMESTER: 2020 - 2021
COURSE NUMBER: Phy 4253 — TIME: 3.0 Hours
COURSE TITLE: Physics II — FULL MARKS: 150

There are **8 (Eight)** questions. Answer any **6 (Six)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. Any other statements, if necessary.

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1. (a) Briefly describe the atomic view of dielectrics. (05) (CO1) (PO1)

   (b) (i) Find the Gauss's law in a dielectric medium. (15) (CO2) (PO2)
   (ii) A conducting sphere of radius R, in a vacuum, carries a charge q. Compute the total electrostatic energy stored in the surrounding. Find the radius R_o of a spherical surface such that half of the stored energy lies within it.

   (c) An air-filled parallel plate capacitor has a capacitance of 1.3 pF. The separation of the plates is doubled, and wax is inserted between them. The new capacitance is 2.6 pF. Find the dielectric constant of the wax. (05) (CO3) (PO2)

2. (a) State what you understand by the electromotive force and potential difference. (05) (CO1) (PO1)

   (b) In case of an RC circuit, obtain expressions for the growth and decay of charge and current with time and show these variations with graphs. (15) (CO2) (PO2)

   (c) A solenoid is 1.0 m long and 3.0 cm in mean diameter. It has five layers of windings 850 turns each and carries a current of 5.0 A. Calculate the magnetic flux for a cross section of the solenoid at its center. (05) (CO3) (PO2)

3. (a) Justify the statement that "the speed of light is constant in every inertial frame". (05) (CO1) (PO1)

   (b) Find the expressions of Lorentz transformation in terms of coordinates of two frames of which one is fixed and another one is moving with constant velocity with respect to the former. (15) (CO2) (PO2)

   (c) How fast must a space craft travel relative to the earth for each day on the spacecraft to correspond to 2 days on the earth? (05) (CO3) (PO2)

4. (a) Define length contraction and time dilation. (05) (CO1) (PO1)

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(b) Show that the relativity of mass can be expressed by $m = \frac{m_o}{\sqrt{1-\frac{v^2}{c^2}}}$. (15) (CO2) (PO2)

(c) Spacecraft Alpha has a velocity with respect to the earth of 0.9c. If spacecraft Beta is to pass Alpha at a relative velocity of 0.5c, what velocity must Beta have with respect to the earth? (05) (CO3) (PO2)

5. (a) Define crystalline and non-crystalline solids with two examples each. (05) (CO1) (PO1)

(b) Mathematically explain the space lattice, translation vectors, Bravais lattice and non- Bravais lattice. (15) (CO2) (PO2)

(c) Calculate the lattice constant for rock salt crystal of density 2210 kg/m^3, assuming that it has fcc lattice. Molecular weight of NaCl is 58.5. (05) (CO3) (PO2)

6. (a) State and explain Wigner-Seitz cell. (05) (CO1) (PO1)

(b) Calculate the number of atoms for simple cubic, body-centered cubic, face-centered cubic and hexagonal close-packed structures with proper figures. (15) (CO2) (PO2)

(c) The lattice parameter and atomic mass of a diamond crystal are 3.54 Å and 12, respectively. Calculate the density of diamond. (05) (CO3) (PO2)

7. (a) Explain atomic packing factor of a crystal structure. (05) (CO1) (PO1)

(b) Calculate the atomic packing factor for hexagonal close-packed structure. (15) (CO2) (PO2)

(c) Show that for hexagonal close-packed crystal, the ratio $c/a = 1.633$. (05) (CO3) (PO2)

8. (a) Explain how to obtain Miller indices. (05) (CO1) (PO1)

(b) Find an expression for the relation between interplanar spacing and Miller indices. Discuss it for orthorhombic, tetragonal and cubic systems. (15) (CO2) (PO2)

(c) Determine the angle through which an X-ray of wavelength 0.443 Å is reflected from the cube face of a rock salt crystal ($d = 2.834$Å). (05) (CO3) (PO2)

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BBA in TM
2nd Semester

Date: 07 April, 2022
Time: 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 — **Summer Semester : 2020 - 2021**
Course Number: EEE 4261 — **Full Marks: 150**
Course Title: Electrical and Electronic Technology II — **Time : 3.0 Hours**

There are **08 (eight)** questions. Answer **06 (six)** questions. The symbols have their usual meanings. Marks of each question are written in the brackets.

---

1. a) i. For the Zener diode network of Fig.1, determine V_L, V_R, I_Z, and P_Z. **(13)**
ii. Repeat part (i) with $R_L = 3\ k\Omega$.

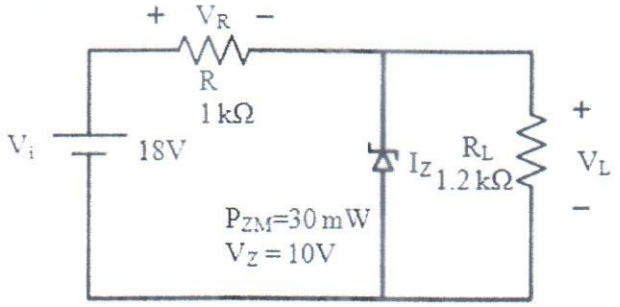

Fig.1

b) Draw circuit diagram of a full-wave bridge rectifier with a sinusoidal input of peak amplitude 120-V. Sketch the voltage across the load resistor and determine the dc voltage available at the load. **(12)**

2. a) Draw the logic circuit for the following equation, simplify the equation, and construct a truth table for the simplified equation. **(13)**

$$X = \overline{(A.\overline{B})} + \overline{A.(\overline{A}+C)}$$

b) i. What are the steps that must be followed in using K-map reduction procedure? Simplify the following equation using the karnaugh mapping procedure: **(12)**

$$X = \overline{A}\overline{B}\overline{C}D + A\overline{B}\overline{C}D + \overline{A}\overline{B}CD + AB\overline{C}D + AB\overline{C}\overline{D} + ABCD$$

ii. Verify your answer using Boolean algebra simplification.

3. a) i. What is the significant difference between the construction of an enhancement-type MOSFET and a depletion-type MOSFET? **(13)**
ii. Sketch an *n*-channel enhancement-type MOSFET with the proper biasing applied ($V_{DS} > 0$, $V_{GS} > V_T$), and indicate the channel, the direction of electron flow, and the resulting depletion region.
iii. Briefly describe the basic operation of an enhancement-type MOSFET.

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b) For the network of Fig. 2, determine: **(12)**
i. V_G ii. I_{DQ} and V_{GSQ} iii. V_D and V_S iv. V_{DSQ}.

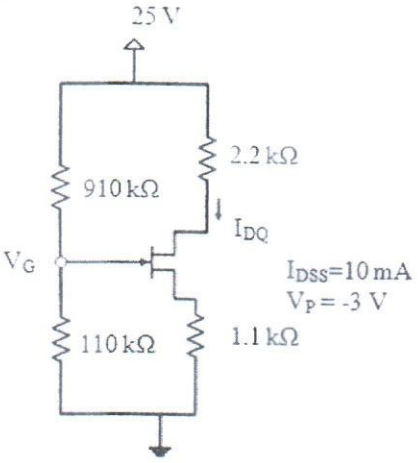

Fig. 2

4. a) For the self-bias configuration of Fig. 3: **(13)**
i. Sketch the transfer curve for the device.
ii. Superimpose the network equation on the same graph.
iii. Determine I_{DQ} and V_{GSQ}.
iv. Calculate V_{DS}, V_D, V_G, and V_S.

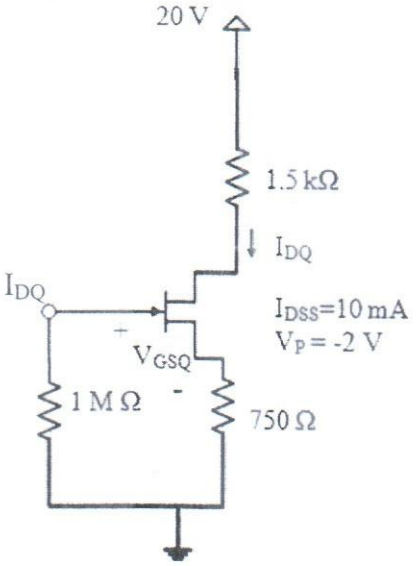

Fig. 3

b) Draw the circuit diagram and derive equation of output voltage for the following Operational Amplifiers: **(06)**
i. Non-inverting Amplifier.
ii. Differentiator Amplifier.
iii. Integrator.

c) Design an op amp circuit with inputs V_1 and V_2 such that $V_0 = -5V_1 + 3V_2$ **(06)**

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5. a) Sketch V_0 for each network of Fig.4. Consider input as square wave with peak amplitude of 120 Volts. **(12)**

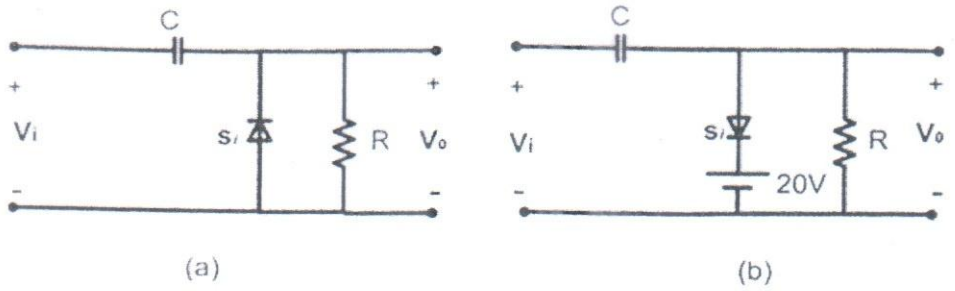

Fig. 4

b) Determine V_0 for each network of Fig. 5. Consider input as sinusoidal wave with peak amplitude of 80 Volts. **(13)**

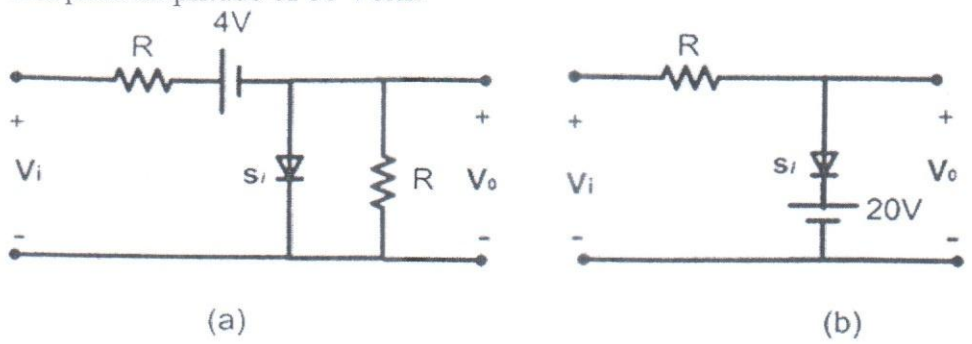

Fig. 5

6. a) Determine the following for the fixed-bias configuration of Fig.6. **(13)**
   i. I_{BQ} and I_{CQ} ii. V_{CEQ} iii. V_B and V_C iv. V_{BC}

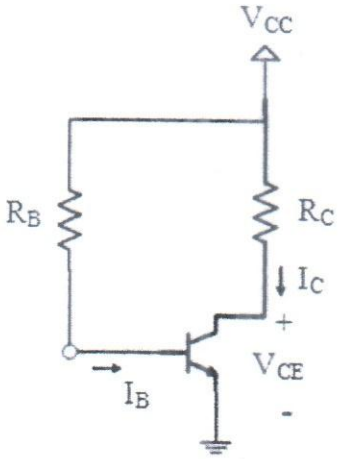

Fig. 6

b) Determine the Load-line for the network shown in Fig.6. Discuss the Movement of the Q-point when: **(12)**
   i. V_{CC} is held fixed and R_C increased,
   ii. R_C is fixed and V_{CC} decreased,
   iii. Both V_{CC} and R_C is held fixed and R_B decreased.

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7. a) Solve the following differential equation using Operational Amplifiers. **(12)**

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} - 10y = 20$$

b) Draw the circuit diagram of a R/2R Ladder Digital-to-Analog Converter and find the output voltage for the following input combinations **(13)**

i. 0001 ii. 0010 iii. 0100 iv. 1010

8. a) Describe the primary differences between JFET and BJT. Draw the basic construction of n-channel JFET and explain the operation and characteristics of the device when $V_{GS} = 0$ V and $V_{GS} < 0$ V. **(12)**

b) Given the characteristics of Fig. 7: **(13)**

i. Sketch the transfer characteristics directly from the drain characteristics.

ii. Use Fig. 7 to establish the values of I_{DSS} and V_P, and sketch the transfer characteristics using the equation given below

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

iii. Compare the characteristics of parts (i) and (ii). Are there any major differences?

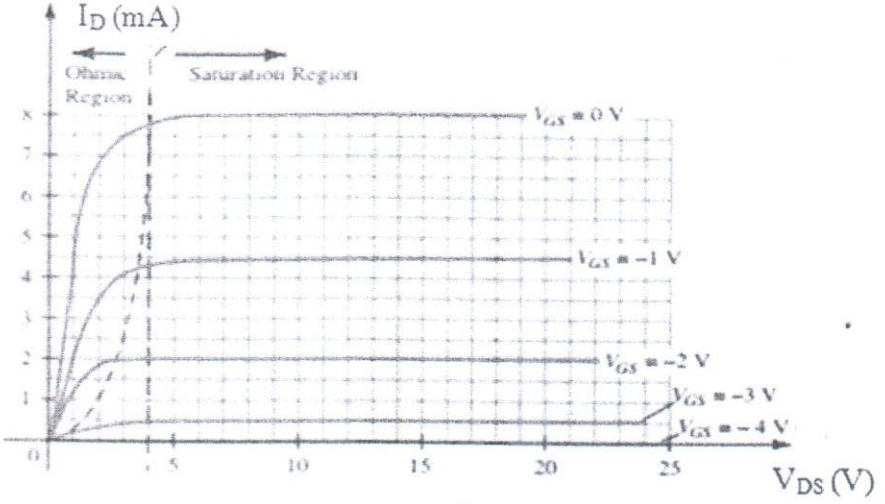

Fig. 7

B.Sc. in MPE
2nd Semester

12 April, 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 4281
Course Title: Basic Electrical Engineering

Summer Semester, A.Y. 2020-2021
Time: 3 hours
Full Marks: 150

There are **6 (six)** questions. Answer **6 (six)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO PO are written in the margin. Do not write on this question paper. Assume reasonable value(s) for missing data if any.

---

1. a) The variable resistor (R_0) in the circuit in Fig. 1(a) is adjusted until the power dissipated in the resistor (R_0) is 250 Watt. Find the values of R_0 which satisfy this condition. 13 CO1 PO1

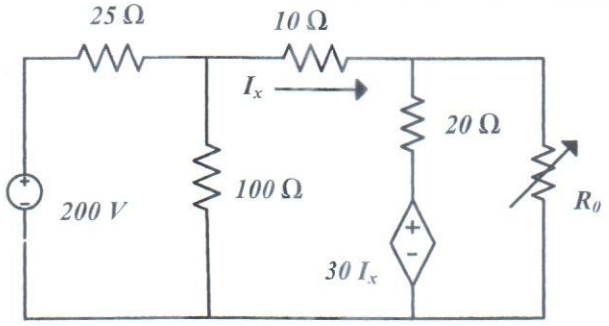

Fig. 1(a)

b) Find the power absorbed/delivered by the dependent source shown in Fig. 1(b) if $V_0 = 12$ V. 12 CO2 PO2

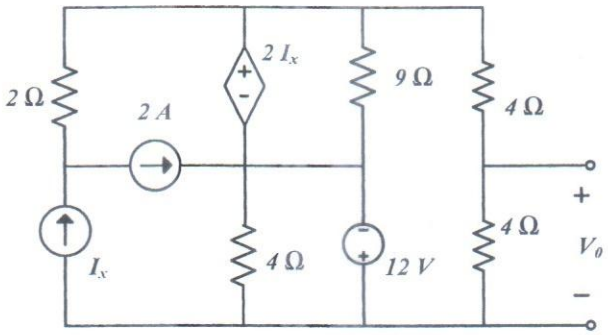

Fig. 1(b)

2. a) Draw the qualitative phasor diagram for the circuit given in Fig. 2(a). Show necessary assumptions if necessary. 5 CO3 PO2

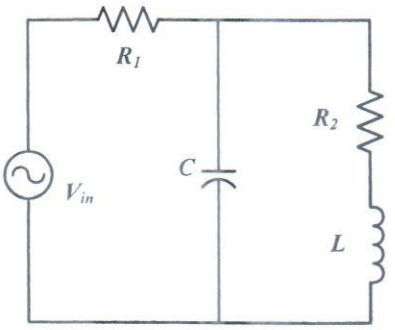

Fig. 2(a)

b) An industrial load operates at 30 kW, 0.8 pf lagging. The load voltage is 240 V. The real and reactive power losses in the transmission line are 1.8 kW and +2.4 kVAR respectively. Find the impedance of the transmission line and the input voltage to the line. 10 CO3 PO2

c) Determine $v_0(t)$ for Fig. 2(c) where, $v(t) = 4 \sin 4t$ V and $i(t) = 3 \cos (4t + 15°)$ A. 10 CO3 PO2

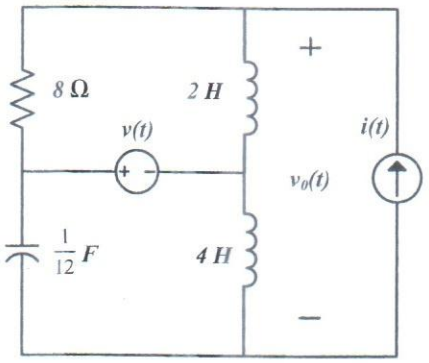

Fig. 2(c)

3. a) i. Proof that Instantaneous power of a three phase system can be constant. 9 CO3 PO2
ii. How do you understand a balanced source and a balanced load in a three phase system?

b) A Δ-connected load has $(9 - j6)$ Ω in each phase and a Y-connected load has $(6 + j8)$ Ω in each phase. They are connected in parallel across a 3-phase line voltage of 230 V. Calculate the total line current, power consumed and the power factor of the combination. 16 CO3 PO2

4. a) Show that for transmission of the same amount of power from one place to another place, the required amount of copper cable in single phase system is 33.33% higher than that of the balanced three phase system. 9 CO3 PO2

b) For the three-phase three-wire system shown in Fig. 4(b), Determine the line currents, line voltages, phase currents and phase voltages at load end. 16 CO3 PO2
Given,
i. Source voltages: $E_{an} = 2000\angle 0$ V, $E_{bn} = 2000\angle -120$ V, $E_{cn} = 2000\angle +120$ V
ii. Source impedances: $Z_{an} = Z_{bn} = Z_{cn} = 2 + j8$ Ω
iii. Line impedances: $Z_{aa'} = Z_{bb'} = Z_{cc'} = 1 + j1.8$ Ω
iv. Load impedances: $Z_{a'n'} = 19 + j18$ Ω, $Z_{b'n'} = 49 - j2$ Ω, $Z_{c'n'} = 29 + j50$ Ω

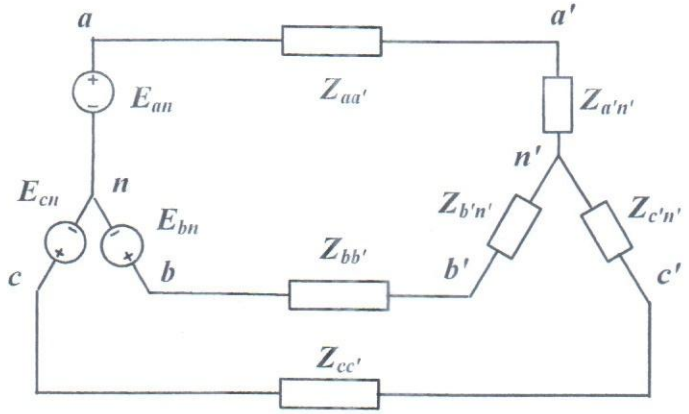

Fig. 4(b)

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5. a) What is mutual inductance? If the mutual inductance of coil 1 with respect to coil 2 is M_{12} and the mutual inductance of coil 2 with respect to coil 1 is M_{21}, then proof that, $M_{12} = M_{21}$. Use necessary diagrams and explanations. 7 CO4 PO1

b) What is dot convention rule? In Fig. 5(b), Z_L is adjusted until it absorbs the maximum average power. Calculate Z_L and the maximum average power absorbed by it. 18 CO4 PO1

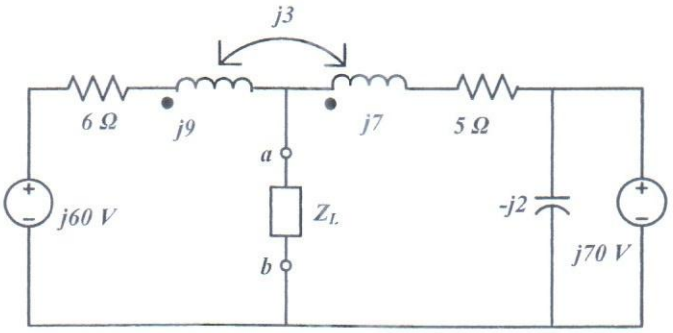

Fig. 5(b)

6. a) Obtain a conductively coupled equivalent circuit for the magnetically coupled circuit shown in Fig. 6(a) where, $V_S = 50\angle 0$ V 9 CO4 PO1

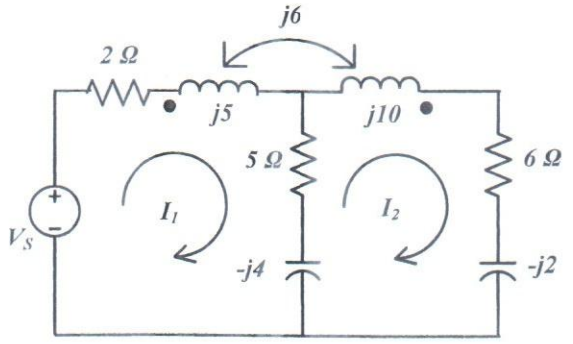

Fig. 6(a)

b) Determine i_x from Fig. 6(b), where, $i_s = 4 \cos 600t$ A and $v_s = 110 \cos (600t + 15°)$ V. 16 CO4 PO1

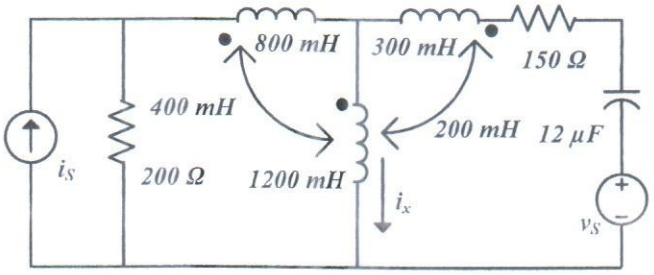

Fig. 6(b)

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Name of the Program: B. Sc. in EEE / DTE
Semester: 4th Sem. / 2nd Sem.

Date: 12 April, 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 — **Summer Semester : 2020 - 2021**
Course Number: EEE 4401/ EEE 4495 — **Full Marks: 150**
Course Title: Power System II — **Time : 3.0 Hours**

There are **06 (six)** questions. Answer **06 (six)** questions. **Question 2 has options. Answer any one.** The symbol(s) have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. Assume reasonable value for any missing data.

1.a) Line to line voltages in an unbalanced three phase supply are $V_{ab} = 600\angle 36.87°$, $V_{bc} = 800\angle 126.87°$ and $V_{ca} = 1000\angle -90°$. A Y-connected load with a resistance of 27 Ω per phase is connected to the supply. Determine the followings ***using Fortescue's theorem***: **(12) (CO2) (PO2)**

i) The symmetrical components of voltage,
ii) The phase voltages,
iii) The line currents.

b) Bus impedance matrix for the network shown in Fig. 1 is given by **(13) (CO2) (PO2)**

$$Z_{bus} = j\begin{bmatrix} 0.300 & 0.200 & 0.275 \\ 0.200 & 0.400 & 0.250 \\ 0.275 & 0.250 & 0.41875 \end{bmatrix}$$

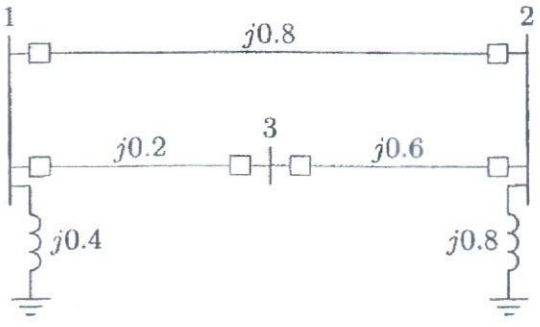

Fig. 1

There is a line outage and the line from bus 1 to 2 is removed. Using the method of ***bus building algorithm,*** determine the new bus impedance matrix.

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2.a) Find a root of the following equation using the ***Gauss-Seidel method*** with an acceleration factor of $\alpha = 1.25$. Perform ***five iterations*** and show the effect graphically. Start with an initial estimate of $x^{(0)} = 2$. **(13) (CO2) (PO2)**

$$f(x) = x^3 - 6x^2 + 9x - 4 = 0$$

b) Use ***Newton-Raphson method*** to find the solution of the following equations: **(12) (CO2) (PO2)**

$$x_1^2 - 2x_1 - x_2 = 3$$
$$x_1^2 + x_2^2 = 41$$

Start with the initial estimates of $x_1^{(0)} = 2$, $x_2^{(0)} = 3$. Perform ***three iterations*** for partial derivatives of the above equations in the Jacobian matrix as follows:

$$J = \begin{bmatrix} 2x_1 - 2 & -1 \\ 2x_1 & 2x_2 \end{bmatrix}$$

OR

2. One line diagram of a simple three bus power system with generation at bus 1 is shown in Fig. 2. The voltage at bus 1 is $V_1 = 1\angle 0^\circ$ per unit. The scheduled loads on buses 2 and 3 are marked on the diagram. Line impedances are marked in per unit on a 100 MVA base. **(25) (CO2) (PO2)**

Using ***Gauss-Seidel method*** and initial estimates of $V_2^{(0)} = 1.0 + j0$ and $V_3^{(0)} = 1.0 + j0$, determine V_2 and V_3. Perform ***four iterations***.

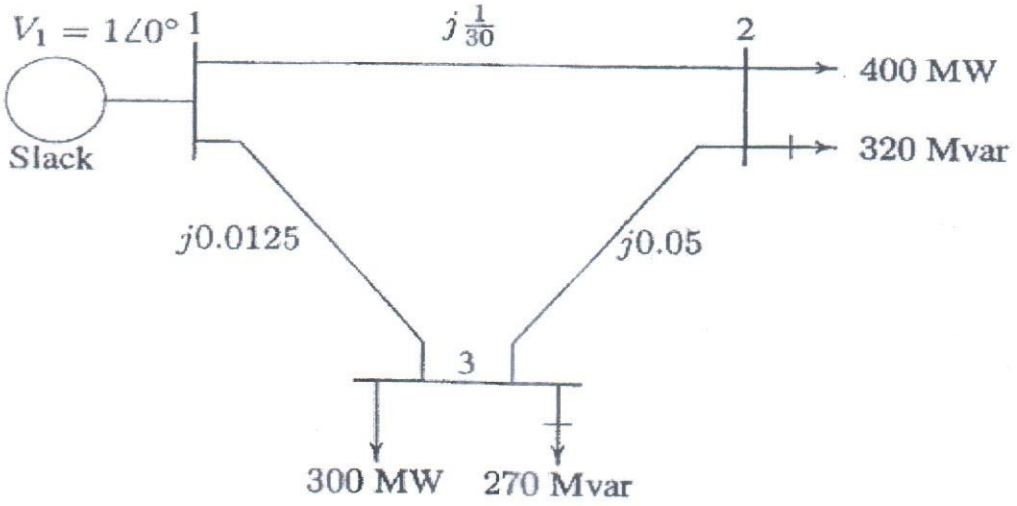

Fig. 2

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3. A balance three phase voltage of 360 V line to neutral is applied to a balanced Y connected load with ungrounded neutral as shown in Fig. 3. Each phase has a series reactance of Z_s = j24 Ω and mutual coupling reactance between phases is Z_m = j6 Ω. Design power system based on sequence impedance, Z^{012} and line currents, I_{abc} considering ***symmetrical component method***. **(10+15) (CO3) (PO3)**

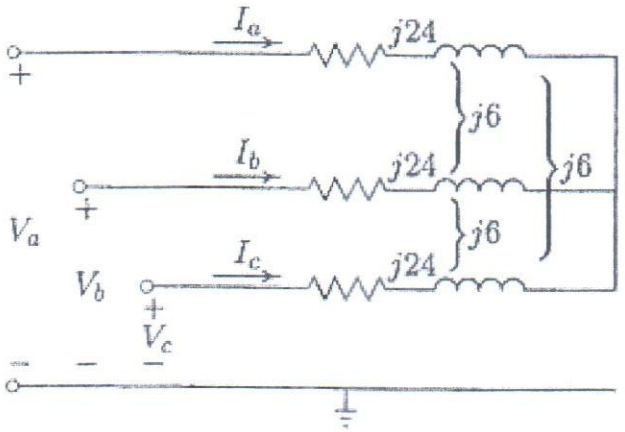

Fig. 3

4. Three phase fault with a fault impedance Z_f = j0.16 per unit occurs at bus 3 in the network shown in the following admittance diagram in Fig. 4. Design the system using the ***bus impedance matrix, Z_{bus}*** method by computing the fault current, bus voltage and short circuit currents in the lines during fault. **(25) (CO3) (PO3)**

$$Y_{bus} = \begin{bmatrix} -j8.75 & j1.25 & j2.5 \\ j1.25 & -j6.25 & j2.5 \\ j2.5 & j2.5 & -j5.0 \end{bmatrix}$$

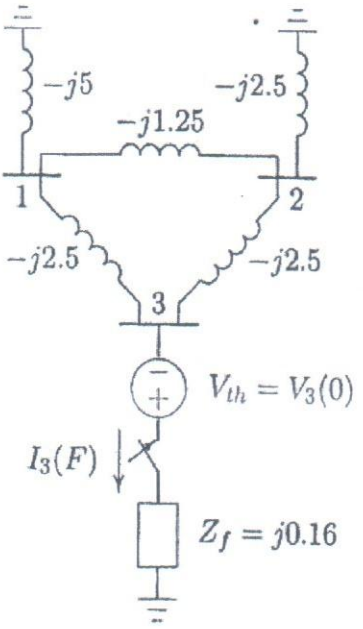

Fig. 4

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5. The zero, positive and negative sequence bus impedance matrices for a three bus power system are given below: **(25) (CO3) (PO3)**

$$Z^0_{bus} = j\begin{bmatrix} 0.20 & 0.05 & 0.12 \\ 0.05 & 0.10 & 0.08 \\ 0.12 & 0.08 & 0.30 \end{bmatrix} \text{ pu}$$

$$Z^1_{bus} = Z^2_{bus} = j\begin{bmatrix} 0.16 & 0.10 & 0.15 \\ 0.10 & 0.20 & 0.12 \\ 0.15 & 0.12 & 0.25 \end{bmatrix} \text{ pu}$$

Design the system for following conditions by calculating ***per unit fault current***:

a) A bolted single line to ground fault at bus 2.
b) A bolted line to line fault at bus 2.

6. Reactance data for the power system shown in the Fig. 5 in per unit on a common base is as follows: **(25) (CO3) (PO3)**

Item	X^1	X^2	X^0
G_1	0.10	0.10	0.05
G_2	0.10	0.10	0.05
T_1	0.25	0.25	0.25
T_2	0.25	0.25	0.25
Line 1–2	0.30	0.30	0.50

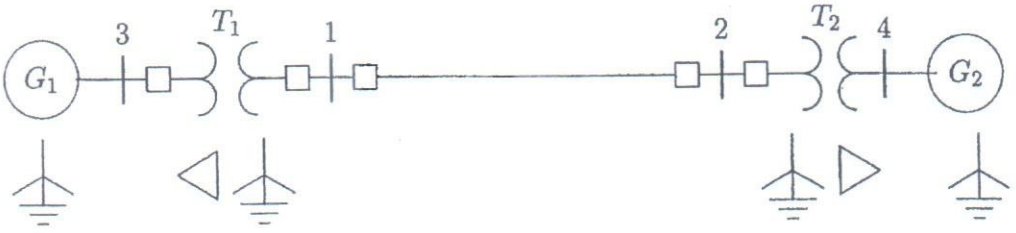

Fig. 5

Obtain the ***Thevenin sequence impedances*** for the fault at bus 1 and compute the fault current in per unit for the design of power system based on following scenarios' :

(a) A bolted three phase fault at bus 1.
(b) A bolted single line to ground fault at bus 1.
(c) A bolted line to line fault at bus 1.
(d) A bolted double line to ground fault at bus 1.

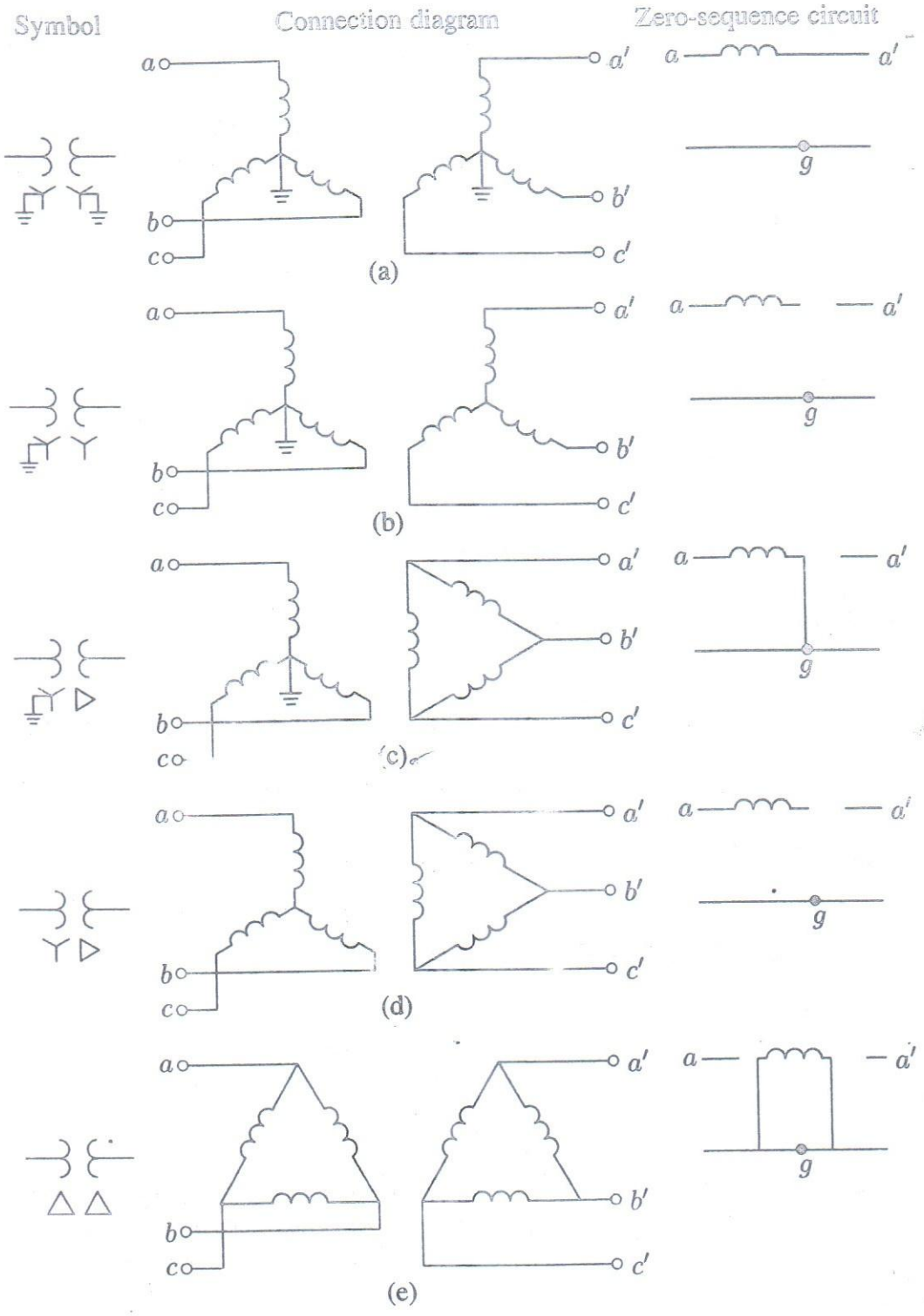

FIGURE 10.6
Transformer zero-sequence equivalent circuits.

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Name of the Program: B. Sc. in EEE
Semester: Summer (4th)

Date: 15th April, 2022
Time: 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 Number: EEE 4403
Course Title: Communication Engineering I

Summer Semester : 2020 - 2021
Full Marks: 150
Time : 3 hours

There are **06 (six)** questions. Answer **06 (six)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. Make reasonable approximation(s) for missing information.

1. a) For an analog sinusoidal signal, show its PAM, PPM and PWM versions. What is clipped PPM? **(10) CO2 PO1-PO4**

   b) An angle modulated signal is described by $x_c(t) = 5\cos[2\pi(10^6)t + 0.2\sin(10^3)\pi t]$. Find m(t) considering the following cases: **(10) CO2 PO1-PO4**
   I. $x_c(t)$ is a PM signal with $k_p = 5$,
   II. $x_c(t)$ is an FM signal with $k_f = 5\pi$.

   c) What are the main advantages and disadvantages of direct method in FM generation? **(5) CO1,CO2 PO1-PO4**

2. a) 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. **(13) CO1-CO4 PO1-PO5**

   b) Why is non-linear modulation termed as a single balanced modulator? Show mathematically why phase modulation is referred to as non-linear modulation. Why are the single sideband (SSB) modulated outputs known as suppressed carrier signals? **(3+5+4) CO2 PO1-PO4**

3. 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) CO1-CO4 PO1-PO4**

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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: i) Modulation index, ii) Sideband frequencies, iii) Amplitude of each sidebands, iv) Bandwidth required, v) Total power delivered to the load of 500 Ω and vi) Modulation efficiency. (12) CO1-CO4 PO1-PO4

c) Mention the repeater spacing, original wire bandwidth, number of channels multiplexed and net total bandwidth of T1 time division multiplexing. (4) CO1-CO4 PO1-PO4

4. 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 and what sort of filter is equivalent to a de-emphasis network? (9) CO1-CO4 PO1-PO4

b) Consider an FM signal obtained from a modulating signal of 2 kHz and maximum amplitude of 5 V. Find the bandwidth using Carson's rule and considering the significant sideband frequencies. Comment on the accuracy of different methods in determining the bandwidth.(Data-sheet attached) (8) CO1-CO4 PO1-PO5

c) 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) CO1-CO4 PO1-PO4

5. a) 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. (3+3+7) CO1-CO3 PO1-PO4

b) Represent the bit stream 10101110 with unipolar, polar, bipolar and Manchester signaling including both RZ and NRZ schemes. (12) CO1-CO4 PO1-PO5

6. a) State the working principle and applications of DPCM. What makes DPCM more advantageous than PCM technique? Define delta and adaptive delta modulation. (10) CO1,CO2 PO1-PO4

b) Why is twisting of pair of insulated wires made in twisted pair cable? Compare between UTP and STP cable. Which coaxial cable type is mainly used for video transmission? (7) CO1,CO2 PO1-PO4

c) How is OQPSK different from QPSK? What was the cellular technology for 3.75G as per 3GPP standard? Name the cellular technology as per IEEE standard. What is a resource element in LTE OFDMA? (8) CO1,CO2 ,CO4 PO1-PO4

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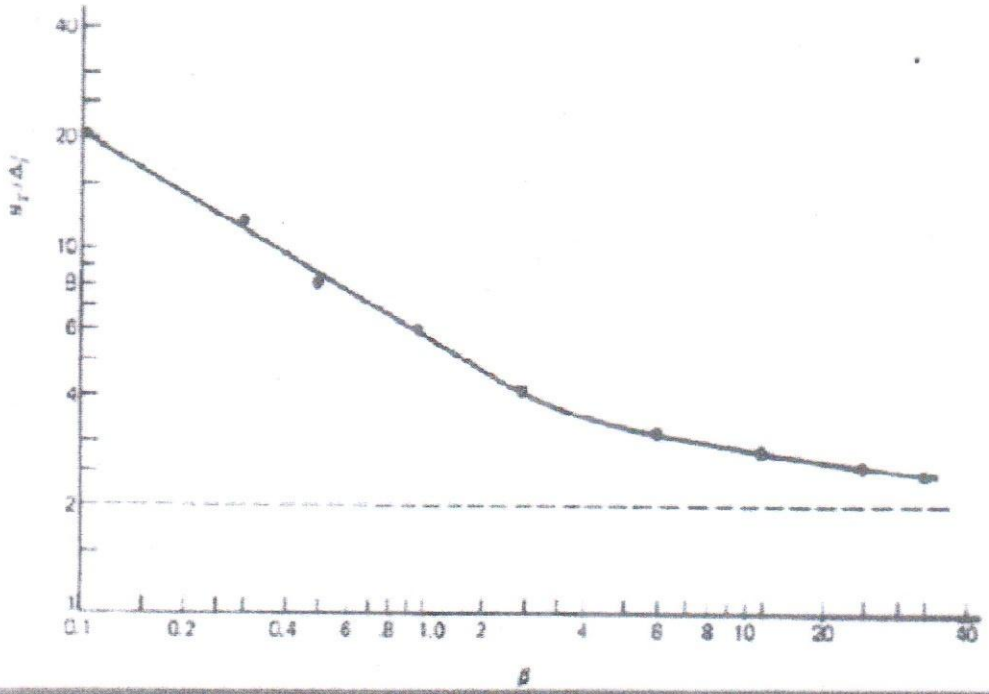
Data-sheet for Q. 4(b)

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

Modulation Index β	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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Program: B. Sc. in EEE 4th Sem , DTE. 2nd Sem
Semester: Summer

Date: 07 April, 2022 (Morning)
Time: 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 Number: EEE 4405 / EEE 4491
Course Title: Energy Conversion II

Summer Semester: 2020 - 2021
Full Marks: 150
Time: 3.0 Hours

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

1. a) Answer the following questions in brief: **(25) (CO1) (PO1, PO2)**
   (i) A large load is connected suddenly to a 3 phase induction motor. Briefly explain the effects on the motor.
   (ii) How can you reverse the direction of a three-phase induction motor?
   (iii) Give two advantages of a wound-rotor motor over a squirrel-cage motor.
   (iv) Why does the rotor of an induction motor rotate slower than the revolving field?
   (v) Briefly describe the electrical braking mechanism of a 3-phase induction motor.
   (vi) Briefly describe the behavior of a 3-phase induction motor if the slip-ring connection of wound rotor is kept open and a 3-phase supply is given to the stator? Explain the behavior for both standstill and running conditions.
   (vii) A 3-phase induction motor is switched on with one phase disconnected. Explain the behavior .
   (viii) For a fixed load connected with a 3-phase induction motor, if the rotor resistance (R_2) is increased, what changes occur to its starting current and running current?
   (ix) Write different methods of making single-phase induction motor 'self-starting'.
   (x) For a single phase split-phase motor, the auxiliary winding is designed to have higher resistance/reactance (R_A / X_A) ratio than the main winding (R_M / X_M). How is this accomplished in the motor industries?

2. a) (i) Name any two important characteristic of a 3 phase synchronous motor not found in 3 phase induction motor. **(2+2 +3) (CO1) (PO1, PO2)**
   (ii) Is it possible to get load angle (δ) equals to zero for a synchronous motor? Explain in brief.
   (iii) Is a synchronous motor self-starting? If not, explain why and write the available methods of starting a synchronous motor.

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b) (i) Draw the equivalent circuit of a synchronous motor. Hence draw the phasor diagram under no-load condition. **(3+3+4) (CO2) (PO1, PO3)**

(ii) Suppose a synchronous motor is running without any mechanical load. Under running condition, if the field supply is disconnected what will happen to this motor? Will it be still running? Explain in brief.

(iii) If the load of the synchronous motor is increased, what will be the change in motor supply current (I_s)? Find the real power consumption and the reactive power consumption. Clearly show all possible changes using different phasor diagrams.

c) A 208 V, Y-connected synchronous motor is drawing 40 A at unity power factor from a 208 V power system. The field current under these conditions is 2.7 A. Its synchronous reactance is 0.8 Ω. **(8) (CO4) (PO1, PO4)**

(i) Find the load angle δ.

(ii) How much field current would be required to make the motor operate at 0.8 pf leading? Find the new torque angle?

3. a) Answer the following questions in brief: **(12) (CO5) (PO1, PO9, PO12)**

(i) Briefly explain the "synchronous condenser" and how it can be used for improving the power factor?

(ii) Show the effect of load in the "V-curve" of a synchronous motor.

(iii) A synchronous motor operates at leading power factor. If you increase the field current, show the changes in real power consumption, reactive power consumption and power factor of the motor using phasor diagram.

b) The infinite bus in Fig.3.b operates at 480 V. Load 1 is an induction motor consuming 100 kW at 0.78 pf lagging, and load 2 is an induction motor consuming 200 kW at 0.8 pf lagging. Load 3 is a synchronous motor whose real power consumption is 150 kW. Find the power factor of the synchronous motor to have the lowest transmission line current in this system. **(13) (CO4) (PO1, PO4)**

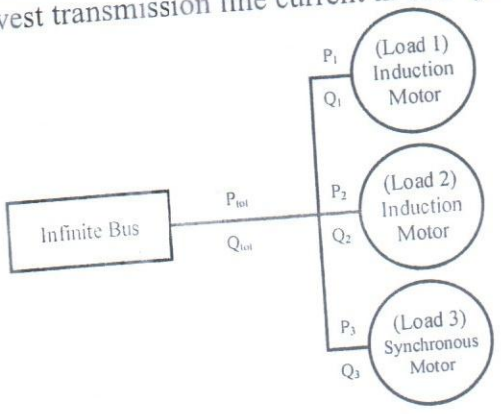

Fig.3.b

4. a) A synchronous generator is operating alone. Show the effects of an increase in generator loads at constant power factor upon the terminal voltage change for the following loading cases: **(15) (CO4) (PO1, PO4)**

(i) Loads with lagging power factor,

(ii) Loads with unity power factor and

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(iii) Loads with leading power factor.
Draw the vector diagram, if all loads are removed from the above mentioned generator.

b) A 200 kVA, 480 V, 50 Hz, Y-connected synchronous generator with a rated field current of 5 A was tested, and the following data were taken: **(10) (CO2) (PO1, PO3)**

(i) $V_{T,OC}$ at the rated I_F was measured to be 540 V.
(ii) $I_{L,SC}$ at the rated I_F was found to be 300 A.

When a dc voltage of 10 V was applied to two of the terminals, a current of 25 A was measured.

5. a) Suppose two generators of IUT: generator 1 and generator 2 are operating in parallel under a certain electrical load (both real load and reactive load are present). Initially both the generators were sharing the load equally. Show the effects of the generators using 'house diagram' for the following cases: **(15) (CO5) (PO1, PO9, PO12)**

(i) only the real power consumptions is increased,
(ii) only the reactive power consumptions is increased,
(iii) the mechanical torque of the generator 1 is increased,
(iv) the field excitation of the generator 2 is increased and
(v) the field excitation of both the generators are increased.

b) For the two generators of IUT mentioned in 5(a), consider a situation when generator 1 has a no-load frequency of 51.5 Hz and a slope S_{p1} of 1 MW/Hz and generator 3 has a no-load frequency of 51.0 Hz and a slope S_{p2} of 1 MW/Hz. The two generators are supplying a real load totaling 2.5 MW at 0.8 pf lagging. The resulting system house diagram is shown in Fig. 6.b. **(15) (CO2) (PO1, PO3)**

(i) Find the operating frequency of the system and how much power is supplied by each of the two generators?
(ii) Suppose an additional 1-MW load was attached to this power system. Find the new system frequency, and how much power would generator 1 and generator 2 supply now?
(iii) With the system in the configuration described in (ii), find the system frequency and generator power if the governor set points of generator 2 are increased by 0.5 Hz?

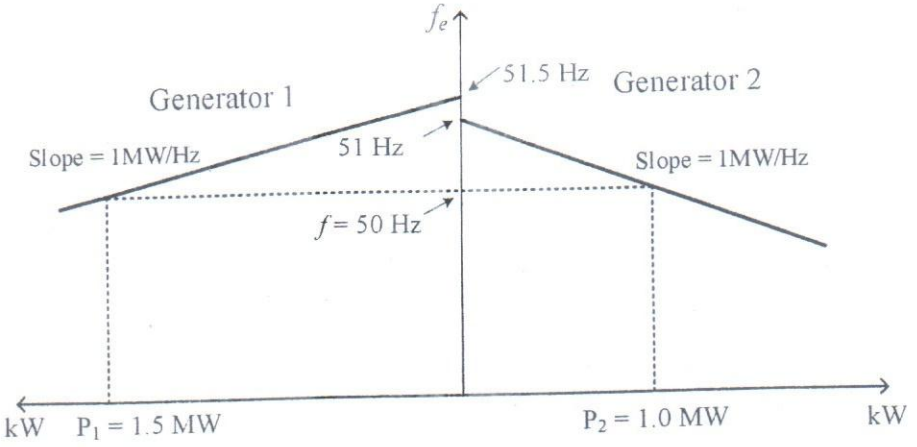

Fig. 6.b

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6. a) Write down the conditions of parallel operation of alternators. Briefly describe the advantages of parallel operation of alternators. **(10) (CO4) (PO1, PO4)**

b) Briefly explain the necessity of taking frequency of the incoming generator a bit higher than the operating frequency while going for the parallel operation of alternators? Is there any problem if you take the frequency a bit lower? Explain using necessary diagrams. **(10) (CO2) (PO1, PO3)**

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B.Sc. Engg. (ME / IPE) 4th Sem. 28 March 2022

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

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination — Summer Semester, A. Y. 2020-2021
Course No.: ME 4407 — Time: 3 Hours
Course Title: Measurement, Instrumentation and Control — Full Marks: 150

There are 6 (Six) questions. Answer all 6 (Six) questions.

Figures in the right margin indicate full marks. Programmable calculators are not allowed.
Do not write on this question paper.

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1. a) What kinds of errors can be seen in an instrument due to environmental inputs? How can you reduce those kinds of errors by calibration? 13

   b) A load cell is calibrated in an environment at a temperature of 20°C and has the following deflection/load characteristic: 12

Load (kg)	0	50	100	150	200	250
Deflection (mm)	0.0	0.9	1.9	3.2	4.2	4.9

   When used in an environment at 35°C, its characteristic changes to the following:

Load (kg)	0	50	100	150	200	250
Deflection (mm)	0.3	1.3	2.4	3.7	4.8	5.7

   i) Determine the zero drift and sensitivity drift coefficients in units of µm/°C and µm/ kg.°C, respectively.
   ii) Calculate the total zero drift and sensitivity drift at 30°C in units of µm and µm/kg, respectively.

2. a) Explain the working principle of the bimetallic strip thermometer with the necessary diagram. Write down the characteristics of the bimetallic strip thermometer. 13

   b) Write down the working principle of a Hall effect sensor. How do you conduct the following tasks using a Hall effect sensor: 12
   i) Sensing a head-on movement
   ii) Sensing a side-by movement
   iii) Sensing a notch
   iv) Sensing a metal body

3. a) How can you measure pressure with the help of a Time-of-Flight sensor? Illustrate your arrangement with the necessary diagrams. 13

   b) Explain the challenges of using standard binary coding in optical encoders. How can you overcome those challenges? 12

4. a) Calculate the digital output of 4.3V using the Successive-Approximation ADC method (10-bit A/D with range 0–10V)? Also, calculate the error (if any). 13

   b) What are the main two primary challenges of A/D conversion? Explain the following terms: 12
   i) Resolution
   ii) Device range
   iii) Signal input range
   iv) Sampling rate

5. a) State the sequence of operations that will occur for cylinders ***A*** and ***B*** in figure 1 when the start button is pressed. Where ***a-***, ***a+***, ***b-***, and ***b+*** (shown in the figure) are limit switches to detect when the cylinders are fully retracted and fully extended. 15

b) Illustrate how you can control a pneumatic lift system with two push-button 2/2 valves. 10

6. a) A proportional controller is used to control the height of water in a tank where the water level can vary from 0 to 4.0 m. The required height of the water is 3.5 m, and the controller is to close a valve fully when the water rises to 3.9 m and open it fully when the water falls to 3.1 m. 18

i) Explain the controlling action with a schematic and flow diagram.

ii) Do you think that Time Proportional Control is needed for the above case? Justify your comment with a proper diagram.

iii) What will be the effect of Proportional Band on this process performance?

b) What are the limitations of two-step (on/off) control, and in what situation such a control system is commonly used? 7

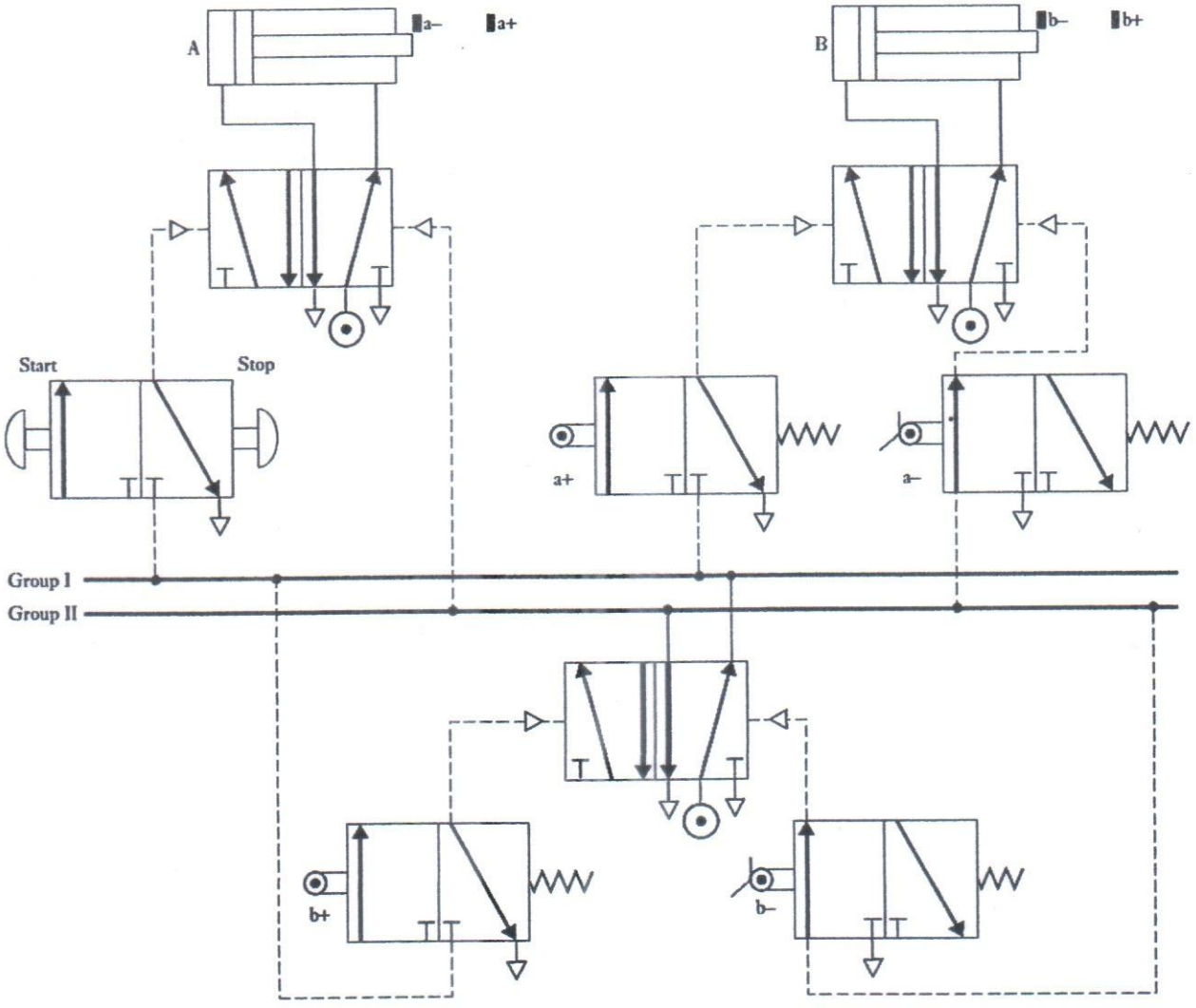

Figure 1 (Question 5 a)

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Name of the Program: B. Sc. in EEE
Semester: 4th Semester

Date: 05 April, 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.: Math 4421
Course Title: Random Signals and Processes

Summer Semester: 2020-2021
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer **6 (six)** questions. **Question 2 has two options** and you have to **answer any one**. Marks of each question and corresponding CO and PO are written in the brackets. Programmable calculators are not allowed. Do not write on this question paper.

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1. a) In a production line for 1000 resistors, the actual resistance in ohms of each resistor is a uniform (950, 1050) random variable R. The resistances of different resistors are independent. The resistor company has an order for 1% resistors with a resistance between 990 Ω and 1010 Ω. An automatic tester takes one resistor per second and measures its exact resistance. (This test takes one second) The random process N(t) denotes the number of 1% resistors found in t seconds. The random variable T_r seconds is the elapsed time at which r 1 % resistors are found. 13 (CO5, PO3)

   i) Evaluate p, the probability that any single resistor is a 1% resistor.
   ii) Evaluate the PMF of N(t).
   iii) Evaluate E [T_1] seconds, the expected time to find the first 1% resistor.
   iv) Determone the probability that the first 1% resistor is found in exactly 10 seconds.
   v) If the automatic tester finds the first 1% resistor in 10 seconds, Determine E [$T_2|T_1 = 20$], the conditional expected value of the time of finding the second 1% resistor.

   b) In an experiment, A, B, C, and D are events with probabilities $P[A \cup B] = 5/8$, $P[A] = 3/8$, $P[C \cap D] = 1/3$, and $P[C] = 1/2$. Furthermore, A and B are disjoint, while C and D are independent. 12 (CO1, PO1)

   i) Find $P[A \cap B]$, $P[B]$, $P[A \cap B^C]$, and $P[A \cup B^C]$.
   ii) Are A and B independent?
   iii) Find $P[D]$, $P[C \cap D^C]$, $P[C^C \cap D^C]$, and $P[C|D]$.
   iv) Find $P[C \cup D]$ and $P[C \cup D^C]$.

2. a) A radio station gives a pair of concert tickets to sixth caller who knows the birthday of the performer. For each person who calls, the probability is 0.75 of knowing the performer's birthday. All calls are independent. 14 (CO2, PO2)

   i) Evaluate the PMF of L, the number of calls necessary to find the winner?
   ii) Determine the probability of finding the winner on the tenth call?
   iii) Evaluate the probability that the station will need nine or more calls to find a winner?

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b) The number of buses that arrive at a bus stop in T minutes is a Poisson random variable B with expected value $T/5$. 11 (CO2, PO2)

i) Determine the PMF of B, the number of buses that arrive in T minutes.
ii) Evaluate the probability that in a two-minute interval, three buses will arrive.
iii) Determine the probability of no buses arriving in a 10-minute interval.
iv) How much time should you allow so that with probability 0.99 at least one bus arrives?

OR

2. a) Explain the families of a discrete random variable X. Include PMF of X, E[X] and Var[X] in your answer. 10 (CO2, PO2)

b) The cumulative distribution function of random variable U is 15 (CO2, PO2)

$$F_U(u) = \begin{cases} 0 & u < -5, \\ \frac{u+5}{8} & -5 \le u < -3, \\ \frac{1}{4} & -3 \le u < 3, \\ \frac{1}{4} + \frac{3(u-3)}{8} & 3 \le u < 5, \\ 1 & u \ge 5. \end{cases}$$

i) Evaluate E[U].
ii) Evaluate Var[U].
iii) Evaluate $E[2^U]$.

3. a) Random variable X and Y have joint PMF 12 (CO3, PO2)

$$P_{X,Y}(x,y) = \begin{cases} cxy & x = 1,2,4\,;\ y = 1,3. \\ 0 & otherwise. \end{cases}$$

i) Determine expected value of $W = Y/X$.
ii) Evaluate $E[XY]$.
iii) Evaluate $Cov[X,Y]$.
iv) Evaluate $\rho_{X,Y}$.
v) Evaluate $Var\,[X+Y]$.

b) Random variables X and Y have joint PDF 13 (CO3, PO2)

$$f_{X,Y}(x,y) = \begin{cases} 2 & 0 \le y \le x \le 1 \\ 0 & otherwise \end{cases}$$

i) Evaluate $E[X]$ and $Var[X]$.
ii) Evaluate E[Y] and Var[Y].
iii) Evaluate Cov[X, Y].
iv) Evaluate E[X + Y].
v) Evaluate $Var[X+Y]$.

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4. a) **X** is the 3-dimensional Gaussian random vector with expected value $\boldsymbol{\mu}_X = [4 \quad 8 \quad 6]'$ and covariance (13 (CO3, PO2))

$$\mathbf{C}_X = \begin{bmatrix} 4 & -2 & 1 \\ -2 & 4 & -2 \\ 1 & -2 & 4 \end{bmatrix}$$

Calculate
i) The correlation matrix, $\mathbf{R}_X$
ii) The PDF of the first two components of **X**, $f_{X_1,X_2}(x_1, x_2)$

b) Given the Gaussian random vector **X** in question 4(a) above, $\mathbf{Y} = \mathbf{AX} + \mathbf{b}$, where, (12 (CO3, PO2))

$$\mathbf{A} = \begin{bmatrix} 1 & 1/2 & 2/3 \\ 1 & -1/2 & 2/3 \end{bmatrix}$$

and $\boldsymbol{b} = [-4 \quad -4]'$

Calculate
i) The expected value, $\boldsymbol{\mu}_Y$
ii) The covariance, $\mathbf{C}_Y$
iii) The correlation, $\mathbf{R}_Y$

5. a) Explain moment generating function. Derive moment generating functions for Binomial, Pascal, Uniform and Exponential random variables. (2+12 (CO3, PO2))

b) J and K are independent random variables with probability mass functions (11 (CO3, PO2))

$$P_J(j) = \begin{cases} 0.2 & j = 1, \\ 0.6 & j = 2, \\ 0.2 & j = 3, \\ 0 & otherwise, \end{cases} \qquad P_K(k) = \begin{cases} 0.5 & k = -1 \\ 0.5 & k = 1 \\ 0 & otherwise \end{cases}$$

Find the MGF of $M = J + K$. What are $E[M^3]$ and $P_M(m)$?

6. a) A telemetry signal, T, transmitted from a temperature sensor on a communications satellite is a Gaussian random variable with E[T] = 0 and Var[T] = 9. The receiver at mission control receives R = T + X, where X is a noise voltage independent of T with PDF (12 (CO4, PO2))

$$f_X(x) = \begin{cases} 1/6 & -3 \le x \le 3 \\ 0 & \text{otherwise} \end{cases}$$

The receiver uses R to calculate a linear estimate of the telemetry voltage:

$$\hat{t}_L(r) = ar + b$$

i) Evaluate E[R], the expected value of the received voltage?
ii) Determine Var[R], the variance of the received voltage?
iii) Evaluate Cov[T, R], the covariance of the transmitted voltage and the received voltage?
iv) Determine the correlation coefficient $\rho_{T,R}$ of T and R?
v) Evaluate a* and b*, the optimum mean square values of a and b in the linear estimator?
vi) Evaluate e_L^* the minimum mean square error of the linear estimate?

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b) Consider an experiment that produces a Bernoulli random variable with probability of success q. In order to estimate q, we perform the experiment that produces this random variable n. In this experiment, q is a sample value of a random variable, Q, with PDF

13 (CO4, PO2)

$$f_Q(q) = \begin{cases} 6q(1-q) & 0 \le q \le 1 \\ 0 & otherwise \end{cases}$$

In Appendix A, we can identify Q as a beta (i = 2, j = 2) random variable. To estimate Q we perform n independent trials of the Bernoulli experiment. The number of successes in the n trials is a random variable K. Given an observation K = k, derive the following estimates of Q:

i) The blind estimate $\hat{q}_B$
ii) The maximum likelihood estimate $\hat{q}_{ML}(k)$
iii) The maximum a posteriori probability estimate $\hat{q}_{MAP}(k)$

Appendix A: Random Variable Beta (i, j)

For positive integers i and j, the beta function is defined as

$$\beta(i, j) = \frac{(i + j - 1)!}{(i - 1)!(j - 1)!}$$

For a $\beta(i, j)$ random variable X,

$$f_X(x) = \begin{cases} \beta(i, j)x^{i-1}(1 - x)^{j-1} & 0 < x < 1 \\ 0 & \text{otherwise} \end{cases}$$

$$E[X] = \frac{i}{i + j}$$

$$\text{Var}[X] = \frac{ij}{(i + j)^2(i + j + 1)}$$

Appendix B: Table for Q(x)

x	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0000	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641
.1000	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
.2000	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
.3000	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
.4000	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
.5000	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
.6000	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
.7000	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
.8000	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
.9000	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
1.000	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
1.100	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
1.200	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.9853E-01
1.300	.9680E-01	.9510E-01	.9342E-01	.9176E-01	.9012E-01	.8851E-01	.8691E-01	.8534E-01	.8379E-01	.8226E-01
1.400	.8076E-01	.7927E-01	.7780E-01	.7636E-01	.7493E-01	.7353E-01	.7215E-01	.7078E-01	.6944E-01	.6811E-01
1.500	.6681E-01	.6552E-01	.6426E-01	.6301E-01	.6178E-01	.6057E-01	.5938E-01	.5821E-01	.5705E-01	.5592E-01
1.600	.5480E-01	.5370E-01	.5262E-01	.5155E-01	.5050E-01	.4947E-01	.4846E-01	.4746E-01	.4648E-01	.4551E-01
1.700	.4457E-01	.4363E-01	.4272E-01	.4182E-01	.4093E-01	.4006E-01	.3920E-01	.3836E-01	.3754E-01	.3673E-01
1.800	.3593E-01	.3515E-01	.3438E-01	.3362E-01	.3288E-01	.3216E-01	.3144E-01	.3074E-01	.3005E-01	.2938E-01
1.900	.2872E-01	.2807E-01	.2743E-01	.2680E-01	.2619E-01	.2559E-01	.2500E-01	.2442E-01	.2385E-01	.2330E-01
2.000	.2275E-01	.2222E-01	.2169E-01	.2118E-01	.2068E-01	.2018E-01	.1970E-01	.1923E-01	.1876E-01	.1831E-01
2.100	.1786E-01	.1743E-01	.1700E-01	.1659E-01	.1618E-01	.1578E-01	.1539E-01	.1500E-01	.1463E-01	.1426E-01
2.200	.1390E-01	.1355E-01	.1321E-01	.1287E-01	.1255E-01	.1222E-01	.1191E-01	.1160E-01	.1130E-01	.1101E-01
2.300	.1072E-01	.1044E-01	.1017E-01	.9903E-02	.9642E-02	.9387E-02	.9137E-02	.8894E-02	.8656E-02	.8424E-02
2.400	.8198E-02	.7976E-02	.7760E-02	.7549E-02	.7344E-02	.7143E-02	.6947E-02	.6756E-02	.6569E-02	.6387E-02
2.500	.6210E-02	.6037E-02	.5868E-02	.5703E-02	.5543E-02	.5386E-02	.5234E-02	.5085E-02	.4940E-02	.4799E-02
2.600	.4661E-02	.4527E-02	.4396E-02	.4269E-02	.4145E-02	.4025E-02	.3907E-02	.3793E-02	.3681E-02	.3573E-02
2.700	.3467E-02	.3364E-02	.3264E-02	.3167E-02	.3072E-02	.2980E-02	.2890E-02	.2803E-02	.2718E-02	.2635E-02
2.800	.2555E-02	.2477E-02	.2401E-02	.2327E-02	.2256E-02	.2186E-02	.2118E-02	.2052E-02	.1988E-02	.1926E-02
2.900	.1866E-02	.1807E-02	.1750E-02	.1695E-02	.1641E-02	.1589E-02	.1538E-02	.1489E-02	.1441E-02	.1395E-02
3.000	.1350E-02	.1306E-02	.1264E-02	.1223E-02	.1183E-02	.1144E-02	.1107E-02	.1070E-02	.1035E-02	.1001E-02
3.100	.9676E-03	.9354E-03	.9043E-03	.8740E-03	.8447E-03	.8164E-03	.7888E-03	.7622E-03	.7364E-03	.7114E-03
3.200	.6871E-03	.6637E-03	.6410E-03	.6190E-03	.5976E-03	.5770E-03	.5571E-03	.5377E-03	.5190E-03	.5009E-03
3.300	.4834E-03	.4665E-03	.4501E-03	.4342E-03	.4189E-03	.4041E-03	.3897E-03	.3758E-03	.3624E-03	.3495E-03
3.400	.3369E-03	.3248E-03	.3131E-03	.3018E-03	.2909E-03	.2802E-03	.2701E-03	.2602E-03	.2507E-03	.2415E-03
3.500	.2326E-03	.2241E-03	.2158E-03	.2078E-03	.2001E-03	.1926E-03	.1854E-03	.1785E-03	.1718E-03	.1653E-03
3.600	.1591E-03	.1531E-03	.1473E-03	.1417E-03	.1363E-03	.1311E-03	.1261E-03	.1213E-03	.1166E-03	.1121E-03
3.700	.1078E-03	.1036E-03	.9961E-04	.9574E-04	.9201E-04	.8842E-04	.8496E-04	.8162E-04	.7841E-04	.7532E-04
3.800	.7235E-04	.6948E-04	.6673E-04	.6407E-04	.6152E-04	.5906E-04	.5669E-04	.5442E-04	.5223E-04	.5012E-04
3.900	.4810E-04	.4615E-04	.4427E-04	.4247E-04	.4074E-04	.3908E-04	.3747E-04	.3594E-04	.3446E-04	.3304E-04
4.000	.3167E-04	.3036E-04	.2910E-04	.2789E-04	.2673E-04	.2561E-04	.2454E-04	.2351E-04	.2252E-04	.2157E-04
4.100	.2066E-04	.1978E-04	.1894E-04	.1814E-04	.1737E-04	.1662E-04	.1591E-04	.1523E-04	.1458E-04	.1395E-04
4.200	.1335E-04	.1277E-04	.1222E-04	.1168E-04	.1118E-04	.1069E-04	.1022E-04	.9774E-05	.9345E-05	.8934E 05
4.300	.8540E-05	.8163E-05	.7801E-05	.7455E-05	.7124E-05	.8807E-05	.6503E-05	.6212E-05	.5934E-05	.5668E-05
4.400	.5413E-05	.5169E-05	.4935E-05	.4712E-05	.4498E-05	.4294E-05	.4098E-05	.3911E-05	.3732E-05	.3561E-05
4.500	.3398E-05	.3241E-05	.3092E-05	.2949E-05	.2813E-05	.2682E-05	.2558E-05	.2439E-05	.2325E-05	.2216E-05
4.600	.2112E-05	.2013E-05	.1919E-05	.1828E-05	.1742E-05	.1660E-05	.1581E-05	.1506E-05	.1434E-05	.1366E-05
4.700	.1301E-05	.1239E-05	.1179E-05	.1123E-05	.1069E-05	.1017E-05	.9680E-06	.9211E-06	.8765E-06	.8339E-06
4.800	.7933E-06	.7547E-06	.7178E-06	.6827E-06	.6492E-06	.6173E-06	.5869E-06	.5580E-06	.5304E-06	.5042E-06
4.900	.4792E-06	.4554E-06	.4327E-06	.4111E-06	.3906E-06	.3711E-06	.3525E-06	.3448E-06	.3179E-06	.3019E-06
5.000	.2867E-06	.2722E-06	.2584E-06	.2452E-06	.2328E-06	.2209E-06	.2096E-06	.1989E-06	.1887E-06	.1790E-06
5.100	.1698E-06	.1611E-06	.1528E-06	.1449E-06	.1374E-06	.1302E-06	.1235E-06	.1170E-06	.1109E-06	.1051E-06

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Name of the Program: B.Sc. Engg. (EE)
Semester: 4th

Date: March 29, 2022
Time: 10:00AM – 1:00PM

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: Phy 4421
Course Title: Semiconductor Devices

Summer Semester, A.Y. 2020-2021
Full Marks: 150
Time: 3 Hours

There are **06 (six)** questions. Answer **all 6 (six)** questions. Question 5 has alternatives. All questions carry equal marks. Marks for parts of the questions and corresponding CO and PO are indicated in the right margin. Programmable calculators are not allowed. Do not write on this question paper. Symbols carry their usual meanings.

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1. a) Using suitable diagram, explain the formation of energy bands in solid Si. — 13 (CO1, CO2) (PO1, PO4)

   b) Define direct bandgap and indirect bandgap semiconductors with examples. Explain the concept of effective mass of charge carriers (for conductivity calculation) in semiconductors. — 8+4 (CO1, CO2) (PO1, PO4)

2. a) Explain how Fermi function varies with electron energy for $T = 0$ K and $T > 0$ K in intrinsic and extrinsic semiconductors. — 13 (CO1, CO2, CO4) (PO1, PO2, PO4, PO5)

   b) A Si sample is doped with 2×10^{17} boron atoms per cm^3. — 2+3+3+4 (CO5) (PO1, PO2)
      i. Find the equilibrium electron and hole concentrations at 300 K.
      ii. Locate equilibrium Fermi level, E_F relative to valence band edge, E_V at 300 K.
      iii. Find the resistivity of the sample at 300 K.
      iv. What Hall voltage would you expect in the same sample of 100 μm thickness if $I_x = 2$ mA and $B_z = 10^{-5}$ Wb/cm^2?

   At 300 K, $n_i = 1.5\times10^{10}$ cm^{-3}, $k = 8.62\times10^{-5}$ eV/K, $\mu_n = 1350$ cm^2/V-s, $\mu_p = 480$ cm^2/V-s and $E_g = 1.12$ eV in Si.

3. a) Using suitable diagram derive the diffusion equations for electrons and holes. — 13 (CO1, CO2) (PO1, PO4)

   b) An abrupt Si p-n junction has $N_a = 10^{17}$ cm^{-3} on p-side and $N_d = 10^{16}$ cm^{-3} on n-side. The junction has uniform cross-sectional area of 2×10^{-5} cm^2. Relative permittivity of Si is 11.8. Calculate: i) W, ii) x_{no}, iii) x_{po} and iv) $\mathscr{E}_0$ where symbols have their usual meanings. — 3×4 (CO5) (PO1, PO2)

4. a) Derive the equations of injected minority carrier concentrations in the neutral regions of a forward-biased p-n junction as functions of distance from the transition region. Using the equations, derive the equation of diode current. — 7+6 (CO1, CO3, CO4) (PO1, PO2, PO4, PO5)

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b) i. What is storage delay time in a p-n junction? 3+5+4 (CO1, CO3, CO4, CO5) (PO1, PO2, PO4, PO5)

ii. Derive the equation of junction capacitance of a p-n junction.

iii. An abrupt Si p-n junction has cross-sectional area, $A = 5\times10^{-4}$ cm^2. Doping on p-side, $N_a = 10^{17}$ cm^{-3} and on n-side, $N_d = 10^{16}$ cm^{-3}. Relative permittivity of Si is 11.8. Find out the junction capacitance, C_j at a reverse-bias voltage of -5 V.

5. a) Explain the Zener breakdown and avalanche breakdown processes in reverse-biased p-n junctions. 6+7 (CO3) (PO1, PO2, PO4)

Or

A metal-semiconductor junction has been formed with $\Phi_m > \Phi_s$. The semiconductor is n-type. Draw the energy band diagram as the function of distance from the junction and explain why the junction is rectifying or ohmic. 7+6 (CO3) (PO1, PO2, PO4)

b) Using energy band diagram as a function of distance in an ideal MOS structure ($\Phi_m = \Phi_s$) with p-type semiconductor under strong inversion, explain how different components of threshold voltage originate. Also, briefly describe the two effects of real surfaces on MOSFET threshold voltage using suitable diagrams. 6+6 (CO3, CO4) (PO1, PO2, PO4, PO5)

Or

Using equation of threshold voltage, explain why and how it varies with substrate doping concentration in both nMOSFET and pMOSFET. 12 (CO3, CO4) (PO1, PO2, PO4, PO5)

6. a) Using I-V characteristics and circuit diagrams, explain how the same photodiode can be used either as a photodetector or as a solar cell. What are the considerations required for designing solar cells? 4+9 (CO2, CO3) (PO1, PO2, PO4)

b) Describe the conditions for successful laser operation. How population inversion can be achieved in semiconductor LASER? 8+4 (CO2, CO3) (PO1, PO2, PO4)

B.Sc. Engg.(CSE)
Semester: 4th

Date: March 29, 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 — **Summer Semester**, A. Y. 2020-2021
Course No.: EEE 4483 — **Time:** 3 Hours
Course Title: Digital Electronics and Pulse Techniques — **Full Marks**: 150

There are **6 (six)** questions. Answer all the questions. All questions carry equal marks. Marks in the margin indicate full marks. Assume the missing values. Programmable calculators are not allowed. Do not write on this question paper. Marks for part of the question and corresponding COs and POs are indicated in the right margin.

---

1. a) A 10-bit DAC has a step size of 10 mV. Determine the full-scale output voltage and the percentage resolution. [4] CO1, PO1

   b) Design a testbench skeleton for the diagram in Fig. 1(b). Consider a clock and reset is also included in the digital circuit. [7] CO3, PO5

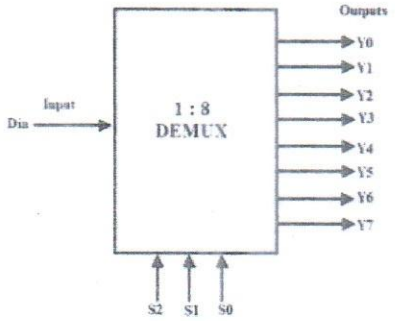

Fig. 1(b)

   c) Illustrate Wein Bridge oscillator showing lag-lead circuit. Write the expression of loop gain and closed loop gain. Step-by-step derive the conditions for growing oscillation and decaying oscillation. Finally, illustrate the relationship between output voltage and frequency, graphically. [14] CO6, PO1

2. a) With necessary diagrams show the differences between common-anode type and common-cathode type 7-segment display. [4] CO3, PO3

   b) For the clipper circuit in Fig. 2(b), sketch the output with and without C_1 and C_2. [7] CO5, PO1, PO2

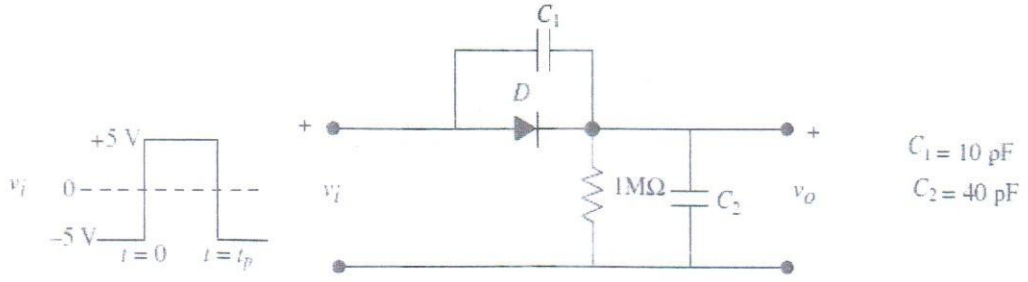

Fig. 2(b)

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c) For a certain 2-bit successive-approximation ADC, the maximum ladder output is + 8V. If a constant +6 V is applied to the analog input, determine the sequence of binary states for the SAR. Repeat the mentioned problem for a 4-bit successive-approximation ADC. [8] CO6, PO1

d) If the analog signal to be quantized (unipolar quantization with 4 bits) has a range from 0 V to 10 V. Determine: (i) number of quantization levels, (ii) quantization step (resolution), (iii) quantization level when the analogue voltage is 7.4 V, and its binary code. (iv) quantization error when the analog input is 7.4 V. (v) quantization level, binary code, and quantization error when the analog voltage is the third sample of the signal $x(t) = |\, 3 \sin(2\pi t) \,|$ sampled at 16 sample/sec. (note that 1st sample is at n = 0) [6] CO6, PO1

3. a) Determine the output of the DAC in Fig. 3a(i) if the sequence of 4-bit numbers in Fig. 3a(ii) is applied to the inputs. The data inputs have a low value of 0V and a high value of +5 V. [6] CO6, PO1

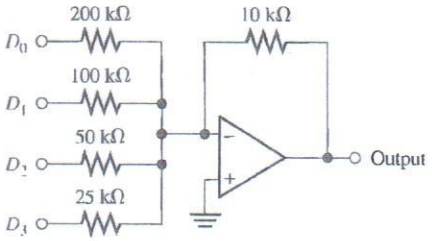

Fig. 3a(i)

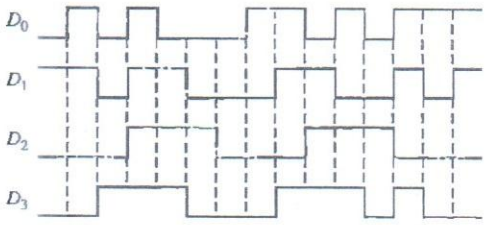

Fig. 3a(ii)

b) Classify same polarity and opposite polarity input. With necessary diagrams derive the expressions of common-mode rejection ratio. [7] CO1, PO1

c) A 3-stage RC phase shift oscillator shown in Fig. 3(c) is required to produce an oscillation frequency of 6.5 kHz. If 1 nF capacitors are used in the feedback circuit, calculate the value of the frequency determining resistors and the value of the feedback resistor required to sustain oscillations. [7] CO6, PO1

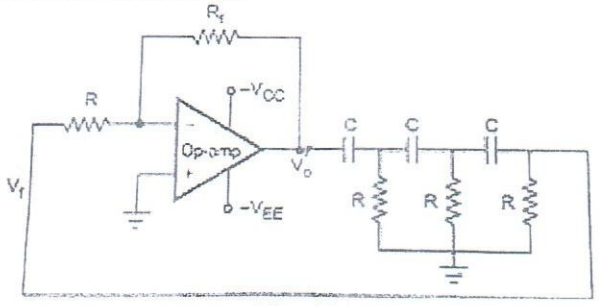

Fig. 3(c)

d) With necessary diagram briefly explain the working principle of sigma-delta ADC. [5] CO1, PO1

4. a) Natural human voice occupies the range of 80 to 3,400 Hz. Human car can tolerate signal-to-noise (SNR) of 40 dB. Assume we want to transmit human voice in digitized form. Determine the bit rate (bps) that should be supported by the channel to enable such transmission. Also determine the possible number of levels with the bit rate. [4] CO1, PO1

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b) Describe the loop gain in terms of oscillator. Illustrate a diagram of a simple oscillator with positive feedback. From the diagram derive the expression of overall system gain. [8] CO6, PO2

c) To achieve a closed-loop voltage gain of 330 with an inverting amplifier, calculate the value of feedback resistor that should be used if $R_i = 1.0\ k\Omega$. [5] CO6, PO1

d) Sketch the schematic of 555 timer in oscillator mode. Discuss the equation of period, frequency and duty cycle. [8] CO1, PO1

5. a) With necessary diagrams show the steps of reconstruction filter. [5] CO1, PO1

b) There are four states in the finite state machine (FSM): A, B, C, and D shown in Fig. 5(b). The system has one input signal called P, and the value of P determines what state the system moves to next. The system also has an output called R which is 1 if in state D, otherwise it is a 0. Here are a few notes about this diagram: i) The circles represent the states ii) Arrows between the circles represent the rules for changing from state to state. For example, in this system, the state machine moves from state A to state B if the input P is equal to 1 (otherwise it remains in state A) iii) The information underneath the line in the circle represents the output value when in each state. iv) The arrow coming from "nowhere" to the A indicates that A is the initial state. [12] CO3, CO4, PO2, PO5

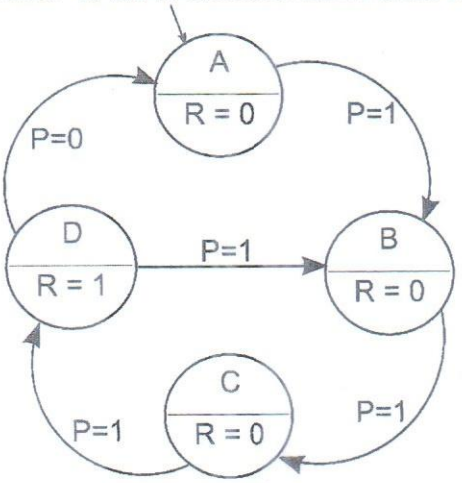

Fig. 5(b)

Design a VHDL process to implement the FSM when clock signal is applied.

c) Sketch the circuit diagram of monostable multivibrator containing op-amp. [5] CO1, PO2

d) Describe the full form of VHDL. Discuss when the ENTITY section remains empty and why? [3] CO1, PO1

6. a) Sketch general memory architectures showing bit lines, word lines, column decoder and row decoder. [6] CO3,

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PO3

b) Sketch 5×5 cascaded DRAM cell. [6] CO3, PO3

c) Illustrate a 5-bit R/2R ladder network connected with an op-amp. Mention the main advantage of such circuit compared to binary-weighted DAC. [3] CO1, PO1

d) Discuss a way to generate an infinite loop in VHDL. [2] CO1, PO1

e) Illustrate the equivalent circuit of crystal-controlled oscillator. Sketch an electronic circuit showing op-amp, Zener diode, XTAL, capacitor and resistors. [2+2] CO6, PO2

f) Sketch three main types (center fixed, edge fixed, width constant) of PWM. [4] CO6, PO1, PO2

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Name of the Program: B. Sc. in Electrical and Electronic Engineering
Semester: 6th

Date: 28 March, 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 4601
Course Title: Signals and Systems

Summer Semester: 2020 - 2021
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 within the brackets.

1 a) Define energy signal and power signal. Give one example for each. 5(CO1, PO1)

b) A discrete time (DT) signal is shown in Fig. 1(b). Find its odd and even parts. Show that the total energy of the signal is the sum of energy of its even and odd parts. 10(CO1, PO1)

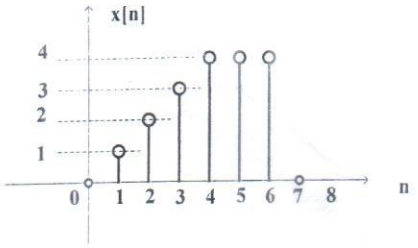

Fig. 1(b)

c) Describe the operation on the independent variable of a DT signal that down samples it? Two DT signals $x[n]$ and $y[n]$ are shown in Fig. 1(c) below. Sketch $x[2n] + y[2n-4]$. 10(CO1, PO1)

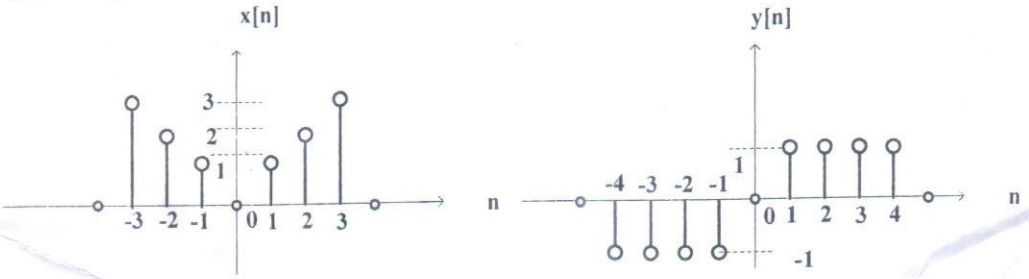

Fig. 1(c)

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2 a) Refer to the first order system depicted in Fig. 2(a), find current through the inductor and $v(t)$ for $t > 0$ by replacing the network into its Thevenin's equivalent with respect to the inductor terminals. 12(CO2, PO2)

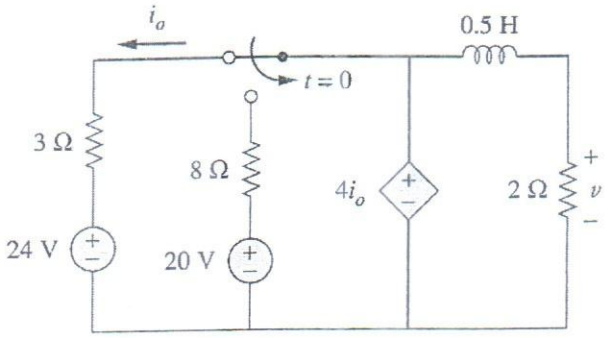

Fig. 2(a)

b) The I/O relation of a second order DT system is given as, 13(CO2, PO2)

$$y[n] + 0.5y[n-1] + 0.25y[n-2] = x[n] - x[n-2]\,.$$

Find the step response for $n \geq 0$, given that $y[-1] = 0.75$ *and* $y[-2] = 0.25$.

3 a) Classify the responses of an LTI systems. How are they determined? 5(CO3, PO1,PO2)

b) Decompose the periodic signal shown in Fig. 3(b) below and use linearty property of Fourier serises to find the CTFS coefficints X[k]. 10(CO3, ,PO2)

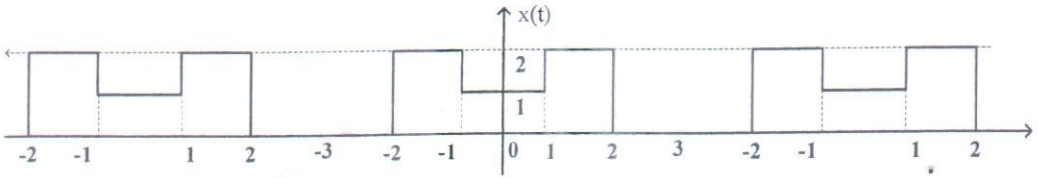

Fig. 3(b)

c) Reconstruct the time domain signal represented by the Fourier coefficients, 10(CO3, PO2)

$$X[k] = -j\delta[k-2] + j\delta[k+2] + 4\delta[k+3] + 4\delta[k-3].$$

The fundamental angular frequency of the signal is $\omega_0 = \pi$.

4 a) If the square wave is applied to the circuit shown in Fig. 4(a), determine the FS coefficients $V_o[k]$, where k is the harmonic number. 13(CO3, PO2)

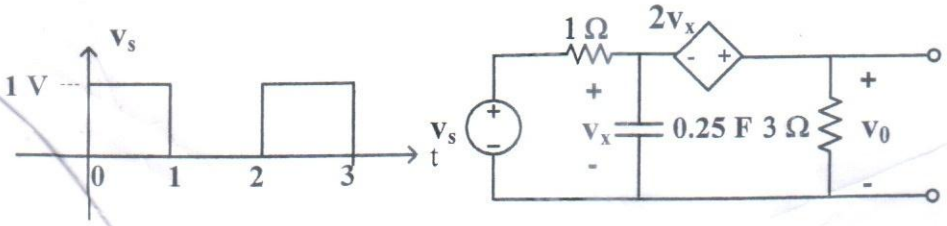

Fig. 4(a)

b) Determine the frequency response and impulse response for the systems described by the following differential and difference equations. 12(CO3, PO2)

(i) $\frac{d^2}{dt^2}y(t) + 5\frac{d}{dt}y(t) + 6y(t) = -\frac{d}{dt}x(t)$

(ii) $y[n] - \frac{1}{4}y[n-1] = x[n] - 2x[n-1]$

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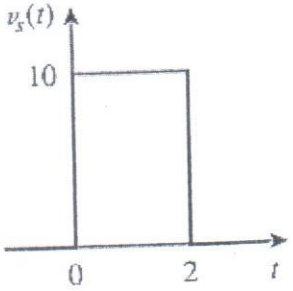
5 a) Use the FT properties to find the FT of the output of an LTI system given as, $y(t) = \frac{d}{dt}\{(e^{-4t}u(t)) * (e^{-2t}u(t-3))\}$. Determine $x(t)$ from is spectrum given as, $X(j\omega) = \frac{e^{j4\omega}}{(2+j\omega)^2}$. 12 (CO4, ,PO2)

b) Find the output as indicated in Fig. 5(b) using FT. 13(CO4, PO2)



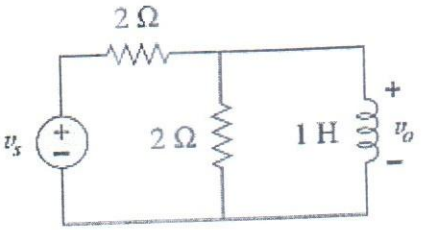


Fig. 5(b)

OR

a) A first order system has the input output(I/O) relation: $\frac{dy}{dt} + 3y = x(t)$. Solve for the ZSR of the system with input x(t) shown in Fig. 5(a-OR). 13(CO4, ,PO2)

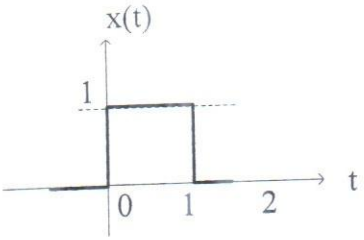


Fig. 5(a-OR)

b) The I/O relation of a second order initially relaxed system is given as, $\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 8y = 12x(t)$ having initial values $y(0_-) = -2.0$ *and* $\frac{dy}{dt}|_{t=0_-} = 1.5$. Find the transfer function and impulse response of the system. 12(CO4,, PO2)

6 a) Show all-possible S-domain configuration of an induction L with initial current and a capacitor C with initial voltage. 10(CO4, PO2,)

b) An initially relaxed system shown in Fig.6 (b) below is excited by $v_s = 5u(t)$ V. Determine (i) $V_o(S)$, (ii) apply initial and final value theorems to determine $v_o(0)$ and $v_o(\infty)$, and (iii) $v_o(t)$ and confirm find $v_o(0)$ and $v_o(\infty)$ obtained in part(ii). 15(CO4, PO2)

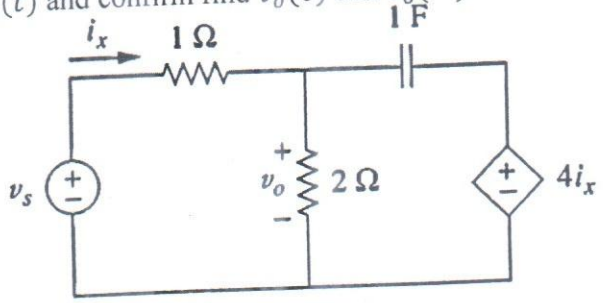


Fig. 6(b)

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B.Sc.Engg.(EE)/HDEE, BScTE
6th, 2nd

06 April, 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 — **Summer Semester: 2020 – 2021**
Course Number: EEE 4603/ 4693 — **Full Marks: 150**
Course Title: Measurement and Instrumentation — **Time: 3 Hours**

There are **06 (six)** questions all carrying equal marks. Students have to answer all 6 questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

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1. **a)** Briefly discuss some mechanical sensing elements that are commonly used in electro-mechanical pressure measurement. **(5) (CO3) (PO1)**

   b) With neat diagram, discuss the differential capacitor design of a capacitive pressure transducer based on the principle of varying the distance between multiple plates. Formulate the expression for differential output and sensitivity for this type of design. **(10) (CO3) (PO2)**

   c) Describe in details the dual slope method of analog to digital (A/D) conversion. **(10) (CO4) (PO2)**

2. **a)** A push-pull non-contact capacitive transducer is shown in Fig. 2(a). It consists of four parallel plates separated by air. Plates A, C and D are fixed and plate B can be moved. Plate B has a thickness t and is at a distance d from plates on either side. Plates B, C, D are all of length l, while plate A has length $2l$. All plates have a width w. The gap between plates C and D can be considered as negligible. Neglecting the end effects, derive expressions for capacitances C_{AC} and C_{AD} for movement of the midpoint of plate B between $x = \pm l/2$. $x = 0$ is the position of symmetry. **(6) (CO3) (PO2)**

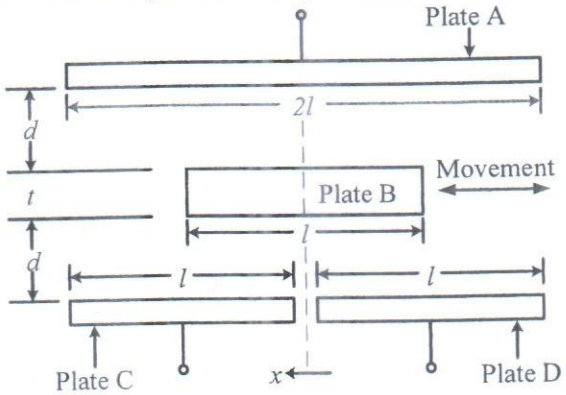

Fig. 2(a)

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b) Sketch the circuit diagram of a 4 bit R-2R ladder digital to analog (D/A) converter and formulate an expression for output voltage. **(9) (CO4) (PO2)**

c) Briefly discuss photodiodes. With proper circuit diagram, discuss how an IR photodiode can be used to form a proximity sensor and explain its working principle. **(10) (CO3) (PO1, PO2)**

3. a) With neat diagrams explain the construction, operation and dynamic behaviour of permanent magnet moving coil (PMMC) mechanism. State the advantages and disadvantages of PMMC mechanism. **(12) (CO1) (PO1)**

b) Design a switching and amplifier gain selection circuit for a PMMC-based electronic analog DC voltmeter using FETs and an OPAMP. The input ranges of the voltmeter should be 50 mV, 100 mV, 1 V, 50 V, 100 V and 200 V. For upper voltage ranges, the input resistance of the voltmeter should be 10 MΩ. Assume that the multiplier resistor along with the PMMC meter is designed for a 1 V input. **(13) (CO1) (PO3)**

4. a) Sketch the circuit diagram of an electrodynamic wattmeter. With necessary formulations, explain how this instrument can be used for measuring DC power and true AC power. Describe the process of linearizing the scale of this type of wattmeter? **(12) (CO1) (PO1, PO2)**

b) Write short notes on any 2 of the following topics: **(8) (CO3) (PO1)**

i) Resistive Temperature Detector
ii) Photo Multiplier Tube
iii) Rotary Variable Differential Transformer
iv) Photo Conductive Cells

c) A 1mA meter movement mechanism with an internal resistance of 50 Ω is to be used in a 0 A to 1 A, 0 A to 5 A and 0 A to 10 A ranges in an Ayrton shunt arrangement of a multirange DC ammeter. Find the values of the required shunt resistances. **(5) (CO1) (PO2)**

5. a) Briefly describe the different types of memory units available in a programmable logic controller (PLC). **(6) (CO5) (PO1)**

b) Briefly discuss the operation of ring counter. Is it possible to manually reset this counter? **(4) (CO5) (PO1)**

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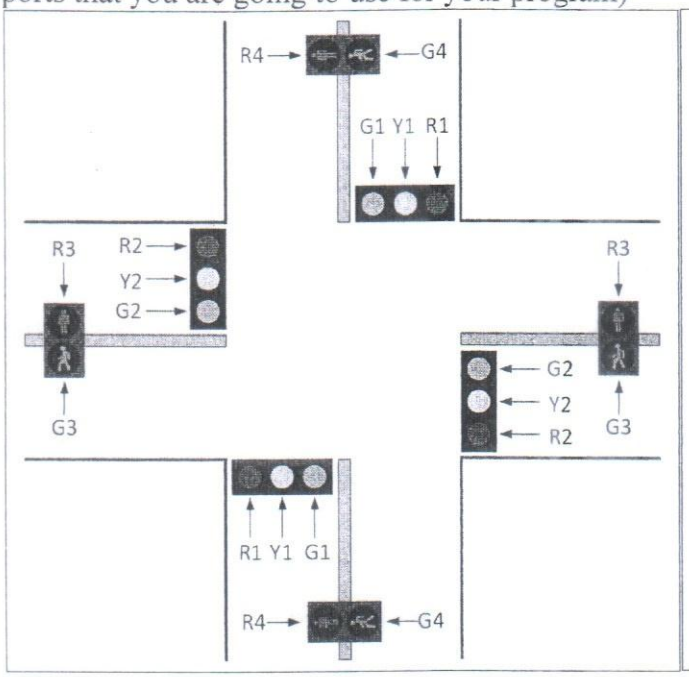
c) Consider the crossroad shown in Fig. 5(c). Deduce a ladder diagram program to implement the control sequence associated with Fig. 5(c). In this figure, vehicle traffic lights and pedestrian traffic lights of two opposite lanes are considered to be operated simultaneously and thus the corresponding lights are indexed with the same symbol. The operator should have the option of manually activating or deactivating the system. (You can consider that the required number of input and output ports are available in the PLC board where the input and output port addresses start with P00 and P40, respectively. Clearly define the input/output devices and the respective input/output ports that you are going to use for your program) **(15) (CO5) (PO3)**



Control Sequence

(i) Turn on R1, G2, R3, G4

(ii) After 30 sec, turn off R1 and G2 while turning on Y1 and Y2 with R3 and G4 still in the on-state

(iii) After 5 sec delay, turn off Y1, Y2, R3, G4. Then, turn on G1, R2, G3, R4

(iv) After 30 sec delay, turn off G1 and R2 while turning on Y1 and Y2 again keeping G3 and R4 in the on-state

(v) After 5 sec delay, turn off Y1, Y2, G3, R4 and continue from step (i)

Fig. 5(c)

6. a) If the timer is set to a delay of 10 sec, sketch the timer output waveshapes for retrigger timer and monostable timer corresponding to the following input trigger pulses as shown in Fig. 6(a). **(6) (CO5) (PO2)**

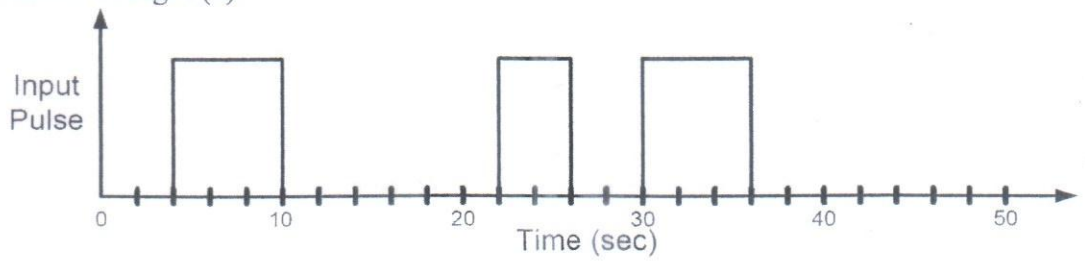


Fig. 6(a)

b) Write the general rules that are followed for PLC ladder diagram programming. **(7) (CO5) (PO1)**

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c) A PLC based automatic door control system has to be implemented. As depicted in Fig. 6(c), the system consists of a motion sensor, an opening limit switch and a closing limit switch as the input devices along with 2 momentary switches to start/stop the system. A green LED should be turned on when the system is activated through the starting switch. When the motion sensor detects the presence of a person, an opening motor should be operated to drive the movable part of the door towards the opening limit switch as shown in Fig. 6(c). When the door touches the opening limit switch, it will send a constant high signal to the PLC as long as the door is in touch with the opening limit switch. This indicates that the door is completely open. At that point, the operation of the opening motor should be stopped and the door should be kept open for 10 sec by setting a timer. Before the delay count is finished, if the motion sensor detects the presence of another person, then the time delay should be reset for another 10 sec. Without interruption, upon completion of 10 sec delay, a closing motor should be operated to move the movable part of the door towards the closing limit switch. When the door touches the closing limit switch, it will send a constant high signal to PLC as long as the door is in touch with the closing limit switch. This indicates that the door is closed and the closing motor should be stopped. Before the door is completely closed, if the motion sensor detects another input, the operation of the closing motor should be stopped and the opening motor should be operated again. Deduce a ladder diagram program to implement the above-mentioned control sequence. (Clearly define the input/output devices and the respective input/output ports that you are going to use for your program) [Hint: for the timer operation use ON delay timer] **(12) (CO5) (PO3)**

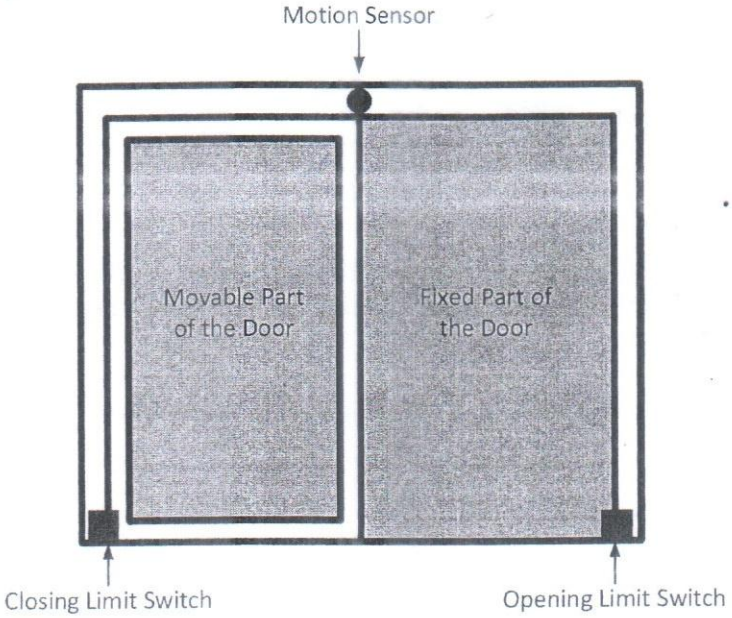

Fig. 6(c)

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B. Sc. in EEE

April 04, 2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

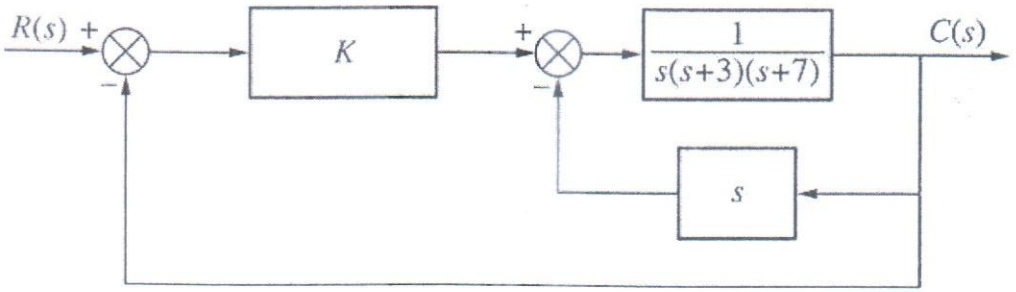
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

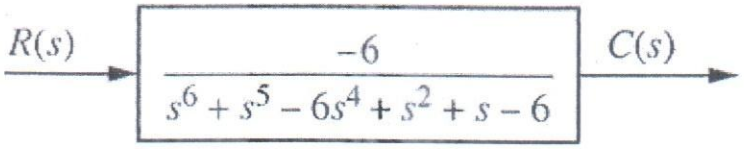
Semester Final Examination — **A.Y. 2020 - 2021**
Course Number: EEE 4605 — **Full Marks: 150**
Course Title: Control System Engineering I — **Time : 3 Hours**

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.

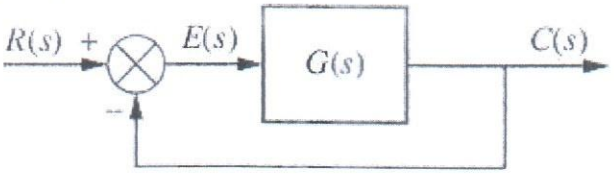
1.a) Consider the system of following figure to find the range of K for closed-loop stability, the value of K that will make the system oscillate, and the frequency of oscillation. **(13) (CO3) (PO2)**



b) Determine how many poles are in the right half-plane, the left half-plane, and on the $j\omega$-axis for the open-loop system of the following figure? **(12) (CO3) (PO2)**



2.a) The unity-feedback system of the following figure with forward path transfer function $G(s)$ shown below, is to be designed to meet the following specifications: steady-state error for a unit step input = 0.1; damping ratio = 0.5; natural frequency = $\sqrt{10}$. Find K, α, and β. **(13) (CO4) (PO3)**



$$G(s) = \frac{K(s+\alpha)}{(s+\beta)^2}$$

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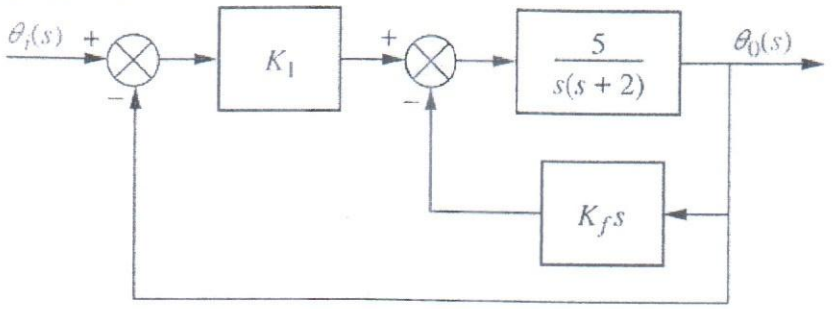
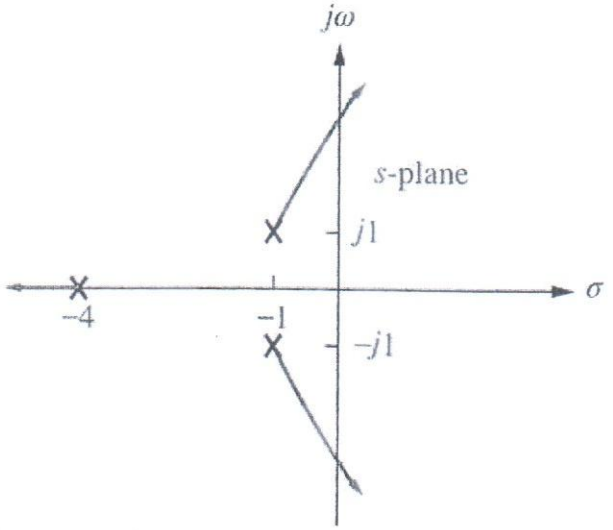
b) The system of the following figure is to have the following specifications: $K_v = 20$; $\zeta = 0.7$. Find the values of K_1 and K_f required for the specifications of the system to be met. **(12) (CO4) (PO2)**



3.a) Given the root locus shown in the following figure **15**
a. Find the value of gain that will make the system marginally stable. **CO4)**
b. Find the value of gain for which the closed-loop transfer function will have a pole on the real axis at −5. **(PO2)**



b) For the unity-feedback system with following forward path transfer function *G(s)*, find the values of α and K that will yield a second-order closed-loop pair of poles at −1 ±j100. **10 CO4) (PO2)**

$$G(s) = \frac{K(s+\alpha)}{s(s+3)(s+6)}$$

4. Sketch the root locus for a unity-feedback system with following forward path transfer function G(s), find the following: **25 CO4) (PO2)**
i. The breakaway and break-in points
ii. The crossing of the jω-axis
iii. The range of K for closed-loop stability
iv. The value of K that will result in a stable system with complex conjugate poles and damping factor of 0.5.

$$G(s) = \frac{K(s-2)(s-3)}{s(s+2)(s+3)}$$

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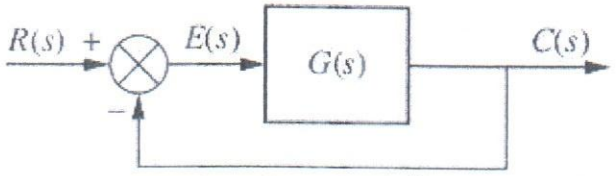
5. Consider the unity-feedback system of ith following forward path transfer function $G(s)$, **25 CO4) (PO2)**
i. Sketch the root locus.
ii. Find the location of the dominant poles when $\zeta = 0.8$.
iii. Find the gain at which $\zeta = 0.8$.
iv. If the system is to be cascade-compensated to attain $T_s = 1$ second and $\zeta = 0.8$, find the compensator pole if the compensator zero is at -4.
v. Justify the validity of your second-order approximation.

$$G(s) = \frac{K(s+5)}{(s+2)(s+3)(s+7)(s+10)}$$

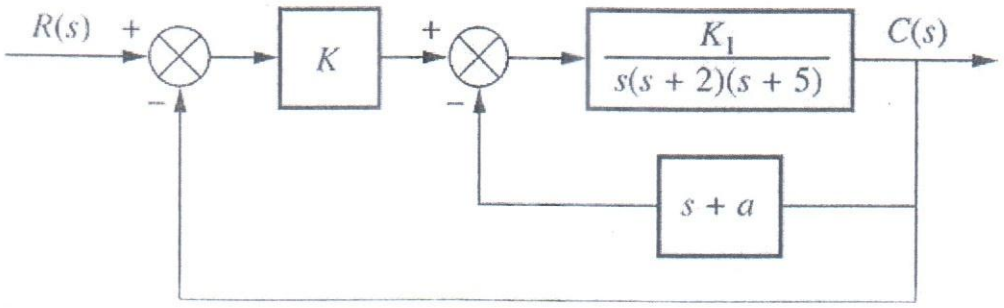
Or

5. Sketch the Bode log-magnitude and phase plots of G(s) for the unity feedback system shown in the following figure. Find phase margin and gain margin. **25 CO4) (PO2)**



$$G(s) = (s+3)/[(s+2)(s^2+2s+25)]$$

6. For the system shown in the following figure: **25**
a. Design the value of K_1, as well as a in the feedback path of the minor loop, to yield a settling time of 4 seconds with 5% overshoot for the step response. **CO4) (PO3)**
b. Design the value of K to yield a major-loop response with 10% overshoot for a step input.



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B.Sc. Engg. (ME)/ 6th Sem. 13 April 2022(Wednesday)
BSc TE 2 year prog/ 2nd Sem

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

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination — Summer Semester, A. Y. 2020-2021
Course No MCE 4621 / 4691 — Time: 3 hours
Course Title: Machine Tools — Full Marks: 150

There are **6(Six)** questions. Answer All of them. Only in Question no 1, one needs to answer Q1[a+b] or Q1[c+d]. Marks in the margin indicate full marks.

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1. a) Write the features that differentiate Non-conventional Machining from the Conventional Machining. Describe working principle of Laser Beam Machining with figures. [12]
   b) Differentiate between a conventional lathe and turret lathe. Also compare between horizontal and vertical milling machine. [13]

OR

   c) Compare between shaper and planer machines. Describe the major five components of a shaper machine and its working principle with appropriate sketches. [3+5+4]
   d) Describe the working principle of a center less grinding machine with neat sketches and when it is used. Also illustrate the impact of grain size in the operation of grinding. [8+2+3]

2. a) Illustrate the main difference between NC and CNC machines. Write down the defining features of Industry 4.0 and its impact on sustainability. [10]
   b) Calculate the indexing and change gears required for 57 divisions using the appropriate indexing method. The change gears supplied with the dividing head are as follows: [15]
   24, 28, 32, 40, 44, 48, 56, 64, 72, 86
   The available index plate hole circles are as follows:

Plate No. 1	15	16	17	18	19	20
Plate No. 2	21	23	27	29	31	33
Plate No. 3	37	39	41	43	47	49

3. a) Describe any two methods that could be used to reduce noise and vibration during installation and operation of machine tools [2+10]
   b) Suppose you are going to do turning on a work piece and need to locate the work piece. Select one locator for this purpose and explain the reason behind this selection. After the locator selection, describe 3-2-1 principle that may be used locating with neat sketches. [2+11]

4. a) Write the differentiating features to be looked for while selecting between jigs and fixtures. Describe any one type of jigs or fixtures with a neat sketch. Explain/ Depict different types and parts of Bearings, slide ways, , clamps, dies, jigs/fixtures for engineering practice [3+9]
   b) Explain the necessity of bearings. Describe the main components of a ball bearing with necessary illustration. [13]

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5. a) Classify Sideways and describe key features of each with appropriate figures. [15]
   b) Briefly describe about Toggle Clamp. Differentiate between V-bending and Edge bending with appropriate figures. [4+6]

6. a) Write down the impact of Service Factor. A 0.5 Hp electric motor is able to move 3000 pounds of potting mixture into a storage box. The motor has a Service Factor (S.F.) of 1.3 and an output of 550 watts. Is this motor capable of performing this task? [2+3]
   b) Draw a structural diagram, speed chart and kinematic diagram for a 6 speed gearbox for a head stock that could provide speed ranging from 160 rpm to 500 rpm. The power is supplied by an electric motor running at 1000 rpm, through a V-belt drive with a speed reduction to 400 rpm to the input shaft. [12]
   c) While selecting a drive, an engineer may prefer hydraulic drive while another engineers prefer pneumatic drive. Write down the advantages of Hydraulic drive and Pneumatic drive that may persuade these two engineers for their choice. Also describe the working principle of a gear pump with figures. [3+5]

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Name of the Program: B.Sc. Engg.(EE)/ HDEE
Semester: 6th

Date: 11 April, 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 4625
Course Title: Utilization of Electrical Energy

Summer Semester: 2020 – 2021
Full Marks: 150
Time: 3.0 Hours

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

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1 a) Define most economic power factor? Determine the expression of the most economic power factor for a consumer. **(7) (CO 1) (PO 1, PO 6)**

b) The daily demands of three consumers are given below: **(8) (CO 2) (PO 2)**

Time	Consumer 1	Consumer 2	Consumer 3
12 A.M to 8 A.M	No Load	200 W	No Load
8 A.M to 2 P.M	600 W	No Load	200 W
2 P.M to 4 P.M	200 W	1000 W	1200 W
4 P.M to 10 P.M	800 W	No Load	No Load
10 P.M to 12 A.M	No Load	200 W	200 W

Sketch the daily load curve and calculate (i) load factor of individual consumer, (ii) diversity factor, (iii) load factor of the station, (iv) utilization factor.

c) A factory load consists of the following: **(10) (CO 1) (PO 2)**
(i) an induction motor of 50 H.P. with 0·8 power factor lagging and efficiency 0·85.
(ii) a synchronous motor of 25 H.P. with 0·9 power factor leading and efficiency 0·9.
(iii) lighting load of 10 kW at unity power factor.
Estimate the annual electrical charges if the tariff is Tk. 60 per kVA of maximum demand per annum plus 5 paisa per kWh; assuming the load to be steady for 2000 hours in a year.

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2 a) A DC series motor drives a load and the torque of the load varies as the square of the speed. The motor current is 20 A when the speed is 400 r.p.m. Measure the speed and current when the motor field winding is shunted by a resistor of the same resistance as the field winding. Neglect all motor losses and assume magnetic circuit to be unsaturated. **(10) (CO 2) (PO 2)**

b) Distinguish between the different types of motor loads used in the industries. Define load equalization and explain importance of flywheel in load equalization. **(15) (CO 1, CO 2) (PO 1, PO 6)**

Derive the following expression for flywheel decelerating where all the terms have their usual meaning:

$$T_M = T_L(1 - e^{\frac{-tg}{IK}})$$

3 a) Define crest speed, adhesive weight, dead weight and accelerating weight of an electric traction system. Sketch the quadrilateral speed-time curve of electric traction system and derive the relationship between speed and distance. **(15) (CO 3) (PO 1, PO 2)**

b) An electric train has quadrilateral speed time as follows: **(10) (CO 4) (PO 2)**

i. Uniform acceleration from rest at 2 km.p.h.p.s for 30 seconds,
ii. Coasting for 50 seconds,
iii. Uniform braking to rest for 20 seconds.

If the train is moving a uniform up gradient of 100 %, train resistance is 40 Newton/tonne, rotational inertia effect is 10 % of dead weight and duration of stops is 30 seconds. Solve the afore-mentioned electric traction system and find the scheduled speed of this electric train.

4 a) Sketch the electrical circuit of a refrigerator and illustrate the operating mechanism of the different components of the electrical circuit of a refrigerator. **(10) (CO 3) (PO 1)**

b) Describe the operating mechanism of a room air-conditioner with neat diagram. **(8) (CO 3) (PO 1)**

c) Diagnose the common faults in a refrigeration system and identify the remedies for those faults. **(7) (CO 3) (PO 4)**

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5	a)	Illustrate the expression of dielectric loss in a dielectric material due to heating when subjected to high frequency ac supply. Determine the loss if DC supply is used instead of AC. Sketch the circuit configuration of the high frequency power supply required for dielectric heating and explain its operation.	**(12) (CO 3) (PO 1)**
	b)	The power required for dielectric heating of a slab made up of resin, 150 cm^2 in area and 2 cm thick is 200 W, at a frequency of 30 MHz. The material has a relative permittivity of 5 and power factor 0.05. Find the voltage necessary and the current flowing through the material. Compute the frequency to obtain the same heating when the voltage is limited to 700 V.	**(8) (CO 4) (PO 2)**
	c)	Describe any two phenomena responsible for causing illumination.	**(5) (CO 3) (PO 1)**
6	a)	Demonstrate the importance of voltage regulator in an automotive system with a neat diagram of the voltage regulator.	**(9) (CO 4) (PO 2)**
	b)	Suppose you are driving a car in long highway and suddenly there is alternator indicator glowing in your dashboard. Identify the causes for the alternator indicator in the dashboard.	**(6) (CO 3) (PO 2, PO 4)**
	c)	Classify the possible causes of any five (5) system troubles that an automotive system encounters while starting. Interpret how to eliminate and correct those troubles associated with the starting system.	**(10) (CO 4) (PO 4)**

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Name of the Program: B. Sc. in EEE
Semester: 6th

Date: 13 April, 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 4637
Course Title: Smart Grid

Summer Semester : 2020 - 2021
Full Marks: 150
Time : 3.0 Hours

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

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1. (a) Explain why DC to DC converter is required for PV system. Mention different MPPT techniques for PV system. Among the different techniques which one is better and why? Explain that method with control circuits. **(15) (CO1) (PO1)**

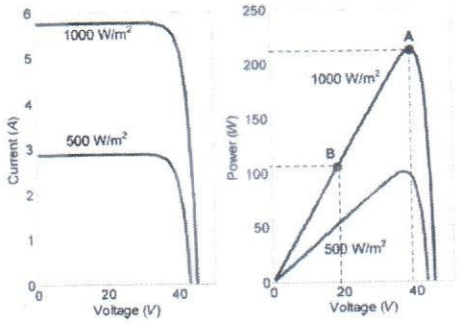

Fig. 1 (a)

(b) Consider the V-I characteristics of two series connected PV modules are shown in Fig. 1 (a). The single-phase inverter operates with sinusoidal PWM and is connected to the 230 V mains. The irradiance on the module is 1000 W/m^2. **(10) (CO2) (PO2)**

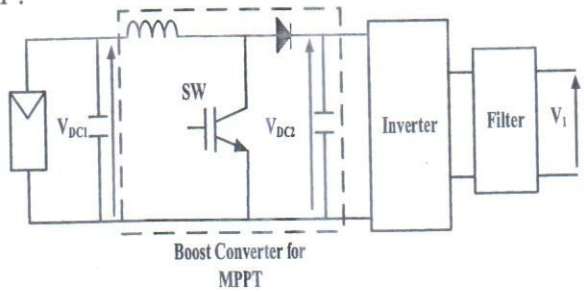

Fig. 1 (b)

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i) Describe a control strategy that can be used for the circuit as shown in Fig. 1 (b).
ii) What should be the amplitude modulation index of the inverter to maintain V_{DC2} at 350 V?
iii) Calculate the duty ratio of the switch SW that is required to extract maximum power.
iv) If the output of the PV system is reduced by 50%, calculate the duty ratio required for the switch SW.

2. (a) Explain the issues that should be considered for future smart grid when it is subject to transients such as three phase faults. How can this problems be solved? **(10) (CO1) (PO1)**

(b) For the part of distribution network shown in Fig. 2(b): **(15) (CO2) (PO2, PO3)**
i) Calculate the three-phase fault current at E with generator G_1 and without FCL.
ii) Design a FCL that can reduce the fault current from 5% to 15% as calculated in (i).

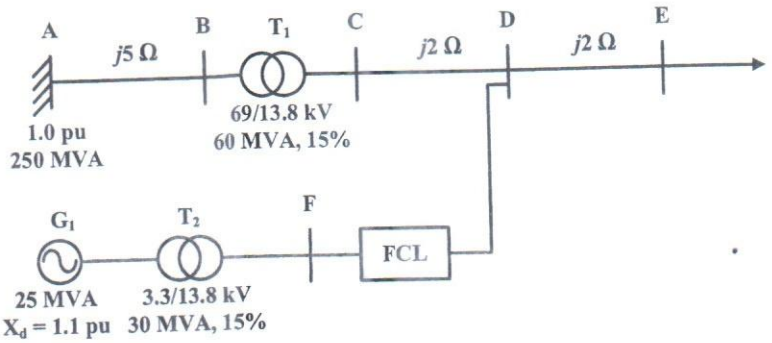

Fig. 2(b)

3. (a) Suppose a wind turbine and PV system is connected at point of common coupling (PCC) which is further connected to the load end by a transmission line. Mathematically prove that the voltage at the load end can fluctuate due to the output power variation of renewable sources. In that scenario which of the following devices you should connect at the load end and explain why. **(13) (CO2) (PO2)**
i) STATCOM
ii) SVC
iii) Energy storage system
iv) Large resistor.

(b) Ten 2 MW wind turbine and a synchronous generator are connected to the network as shown in Fig. 3 (b). Each wind turbine is providing 1.0 + j 0.5 pu apparent power based on their rating. The synchronous generator is providing 0.75 + j .05 pu apparent power based on its rating. Consider the **(12) (CO2) (PO2)**

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voltage at the wind firm and synchronous generator busbar (W) 1.05 ∠0°. Neglect the active and reactive power loss within wind farm, synchronous generator and the transformer connected to it. Considering the new base to be 100 MVA, calculate:

i) The reactive power that should be absorbed or generated by a STATCOM connected at PCC to maintain the power factor at PCC 0.95 exporting vars.

ii) The pu voltage at the STATCOM terminal (X point) to enable STATCOM operating as described in (i).

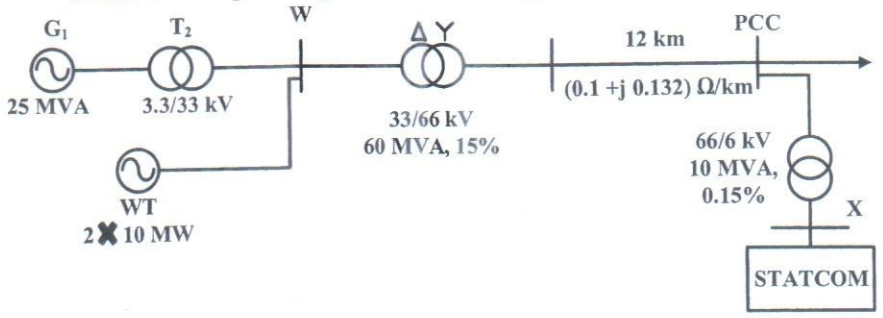

Fig. 3(b)

4. **(a)** Explain what the constrains of existing transmission system are in incorporating renewable resources. How can these constrains be overcome? Explain what benefits of series compensation are with the precautions that should be considered while it is connected to the transmission line. **(13) (CO1) (PO1)**

(b) A 12-pulse rectifier is used for HVDC line as shown in Fig. 4(b). The effective turn ratio, n, of the transformer is 0.4. When the primary voltage is 220 kV, the firing angle delay is 15°, the dc current delivered by the rectifier is 1000 A. Consider the dc line is 2 Ω/line and each 6-pulse converter has an equivalent commutating resistance of 2 Ω. **(12) (CO2) (PO2)**

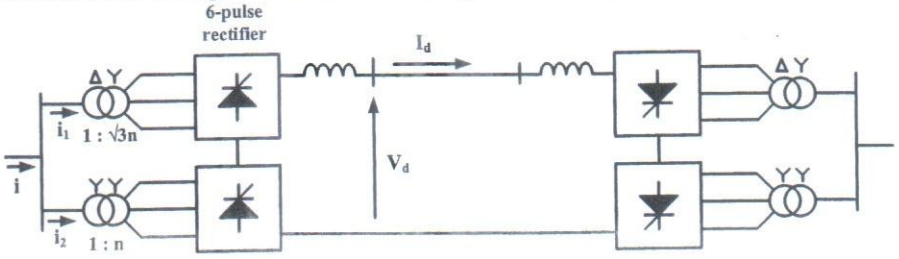

Fig. 4 (b)

Calculate:

i) DC link voltage

ii) RMS current

iii) Reactive power absorbed by 12-pulse converter

iv) Angle β.

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5. (a) Explain the beneficial features of UPFC with vector diagram which make it more effective and unique as compared to the STATCOM and SVC. Is it possible to transfer the real power from one transmission line to another using FACT devices? Explain your answer. (13) (CO1) (PO1)

(b) For the network shown in Fig. 5(b), evaluate for two iterations of the forward/backward method. All the quantities are in per unit on 20 kV, 100 MVA base. (12) (CO2) (PO2)

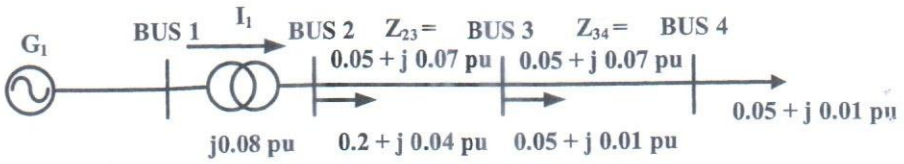

Fig. 5 (b)

6. (a) Explain the beneficial features of smart metering. (07) (CO1) (PO1)

(b) Explain with figures the significance of demand side integration (DSI). Briefly describe different price based DSI schemes. (08) (CO1) (PO1)

(c) Consider the circuit shown in Fig. 6 (c) (I). The 33/11 kV transformer has an on-load tap changer which maintains the load voltage at 11 kV. Calculate the percentage reduction in energy loss in the 33 kV line if the load shifting is managed as shown in Fig. 6(c)(II). Ignore the 33/11 kV transformer losses. (10) (CO2) (PO2)

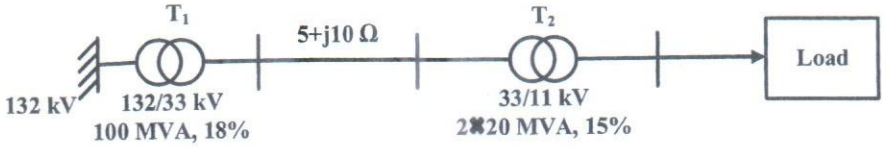

Fig. 6 (c) (I)

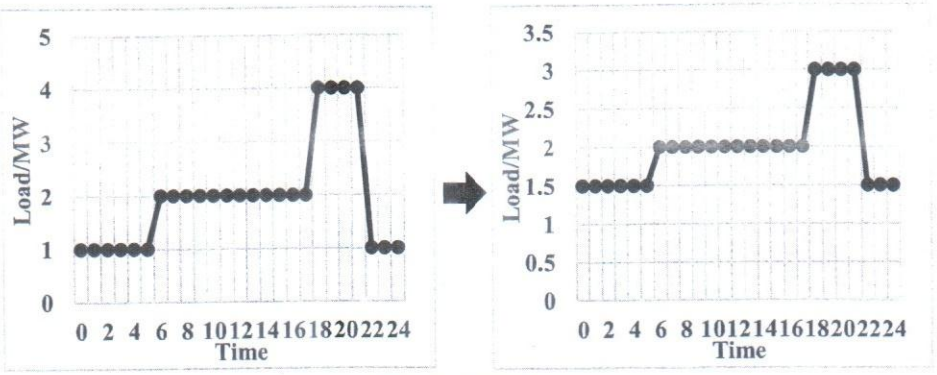

Fig. 6 (c) (II)

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Name of the Program: B.Sc. in EEE | **Date: 11 April, 2022**
Semester: 6th | **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 | **Summer Semester : 2020 - 2021**
Course Number: EEE 4641 | **Full Marks: 150**
Course Title: Cellular Communication | **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 COs and POs are written in the brackets.

---

1. (a) Sketch the network architecture for LTE. **(5) (CO1, PO1)**

(b) Describe briefly how the downlink synchronization takes place and the physical cell identifier (PCI) is detected on a new cell. **(8) (CO1, PO1)**

(c) The radio frames are numbered using the system frame number (SFN) and the subframes are numbered from 0 through 9. On subframe 5 of a radio frame with SFN 1000, the PDCCH allocates both uplink and downlink resources. Because of the poor radio link, all three HARQ retransmissions have occurred for both uplink and downlink. For downlink data transfer, all retransmissions have used the gap of 5 subframes. For both uplink and downlink, determine the subframe number and radio frame SFN, on which the last retransmissions have occurred. **(12) (CO2, PO2)**

2. (a) State the relationship between MME pool area and TAI list. Why does the UE need to read MIB before it can read SIB type 1? **(6) (CO1, PO1)**

(b) State how many HARQ operations can run in parallel and justify this number of parallel operations. **(6) (CO1, PO1)**

(c) The initial attach or TAU is triggered in a particular TA and a particular TAI list is sent according to Table 1. A UE first performs initial attach in TA1. Then it moves through different TAs and also, 3 Paging messages are transmitted according to the sequence shown: TA1 → TA2 (Paging message 1) → TA5 → TA6 →TA4 (Paging message 2) → TA7 → TA1 → TA2 (Paging message 3). Assume that there is no periodic TAU. **(13) (CO2, PO2)**

For each of the 3 Paging messages (Paging message 1, Paging message 2, and Paging message 3), determine which TAs, the Paging messages are transmitted in.

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Initial Attach or Tracking Area Update (TAU)	Tracking Area Identity (TAI) list
TA1	TA1, TA2
TA2	TA1, TA2, TA3
TA3	TA2, TA3, TA5
TA4	TA4, TA7
TA5	TA4, TA5, TA6
TA6	TA6
TA7	TA1, TA2, TA3, TA7

Table 1

3. (a) It is a common experience with the sound system that when someone speaks in front of a microphone with his mobile phone in his pocket, the sound sometimes gets distorted for a very short period. Explain the reason for this sound distortion. **(6) (CO1, PO1)**

(b) In case of uplink data transfer, state the advantage of nonadaptive and synchronous HARQ retransmissions. Also, explain why adaptive HARQ retransmissions are used sometimes and show the orders of redundancy versions (RVs) in nonadaptive and adaptive cases. **(9) (CO1, PO1)**

(c) For paging in a cell, the DefaultPagingCycle is 256 and NB is 4. Determine which radio frame positions can be used by the eNodeB for transmissions of paging messages in a paging cycle. **(10) (CO2, PO2)**

4. (a) Explain how a voice call is set up in VoLTE in terms of access point name (APN), EPS bearers and their QCI values. **(8) (CO1, PO1)**

(b) State which significant things are set up during the initial attach procedure. Explain the function of new data indicator (NDI). **(8) (CO1, PO1)**

(c) Discuss the problems of using very high or very low values for the TimeToTrigger timer. State which parameters are scaled for speedy users in cell reselection and why this scaling is required. **(9) (CO1, PO1)**

5. (a) How many physical cell identifiers (PCIs) are available in total in 4G and 5G? Discuss the advantage of higher number of PCIs. **(7) (CO2, PO2)**

(b) Explain how the resource allocation has been made more flexible in 5G compared to 4G. **(8) (CO1, PO1)**

(c) User A and user B are using 5G with the same radio link conditions. In every second, User A is allocated 5 resource blocks at 120 kHz subcarrier spacing for 100 ms. The data rate of user A is 2 Mbps. In every second, User B is allocated 5 resource blocks at 30 kHz subcarrier spacing for 200 ms. Calculate the data rate of user B. **(10) (CO1, PO1)**

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6. **(a)** Write down the number for RRC specifications of 3G and 5G. State what information a UE sends to the eNodeB on a measurement report. **(7) (CO1, PO1)**

(b) Considering the user plane, show which layers are implemented in the distributed unit (DU) and which layers are implemented in the centralized unit (CU) for 5G. Show the steps up to reading SIB1 after a UE is powered up in 5G. **(10) (CO1, PO1)**

(c) For 5G, state the maximum number of carrier components and the maximum bandwidth possible for a UE in FDD and TDD. State two features, which have been introduced in 5G and they do not exist in 4G, however, 3G had features similar to them. **(8) (CO1, PO1)**

1B3

B. Sc. in EEE
Semester: 6th

13 April 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: EEE 4651
Course Title: Data Communication and Networking II

Summer Semester: 2020 - 2021
Full Marks: 150
Time: 3.0 Hours

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

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1. a) Clarify why is IEEE 802.11 (WiFi) suitable for WLAN (wireless local area network) standard. Justify the features of WiFi that help to adopt the wireless technology in LAN. **(15) (CO1, CO3)**
   b) Briefly discuss the Performance matrices of IEEE 802.11. **(PO1)**
   c) Briefly explain how Power Management in IEEE 802.11 works.

2. a) Briefly explain the roles of Source, Actuator, and Sink in wireless sensor Networks (WSN) using suitable illustrations and diagrams. **(15) (CO1, CO3)**
   b) Briefly discuss the five application types of wireless sensor Networks (WSN) using suitable illustrations and diagrams. **(PO1)**

3. a) Define Delay Tolerant Networks (DTN)? **(15)**
   b) Discuss the problems in the current TCP/IP model associated with the Internet and how DTN overcomes those problems. **(CO1, CO2)**
   c) Explain the following characteristics of DTN: **(PO1)**
      i) store-carry-forward,
      ii) custody transfer,
      iii) bundle layer.

4. Suppose you are working in the forest ministry as a network specialist. **(35) (CO1, CO2, CO3, CO4, CO5) (PO1, PO2, PO3, PO4)**

   Your task is to design a biodiversity mapping of tigers in Sundarbans with the help of wireless sensor networks (WSN) to find out the cause of decreasing the number of population and characteristics of tigers.

   How do you design the biodiversity-mapping networks? Use suitable illustrations, diagrams, and flowcharts.

   For your above design,
   a) Explain the architecture and functionality of your design.
   b) Identify and solve the problems associated with your design.
   c) Use and apply the suitable techniques, skills, and modern engineering tools of data flow mechanisms in wireless data communication networking.

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5. You are asked to design an Internet of Energy (IoE) using the smart devices to provide a suitable scheduling plan for the efficient utilization of smart home appliances (such as light, fan, television, air-condition, washing machine, electric oven, hairdryer, refrigerator, etc.), and smart energy equipment (such as smart meters, smart substations, etc.). **(35) (CO1, CO2, CO3, CO4, CO5)**

How do you design the above IoE considering: i) peak hour and off-peak hour, ii) day and night, iii) summer and winter season, and iv) the number of the occupant in the home? **(PO1, PO2, PO3, PO4)**

For your above design,

a) Explain the architecture and functionality of your design.
b) Identify and solve the problems associated with your design.
c) Use and apply the suitable techniques, skills, and modern engineering tools of data flow mechanisms in wireless data communication networking.

Use suitable illustrations, diagrams, and flowcharts.

6. As a network engineer, to build a real-world sustainable, practical product, briefly explain the following five steps: **(35) (CO1, CO2, CO3, CO4, CO5) (PO1, PO2, PO3, PO4)**

Step1: Define the problem and find the expected solution and hypothesis,
Step2: Create the mathematical model,
Step3: Create the simulation model,
Step4: Develop the prototype of the practical product,
Step5: Find the socio-economic impact of your product.

By adopting the above five steps, design a vehicular Ad-hoc networking for an autonomous car (like Google or Tesla car). Use suitable illustrations, diagrams, and flowcharts.

For your above design,

a) Explain the architecture and functionality of your design.
b) Identify and solve the problems associated with your design.
c) Use and apply the suitable techniques, skills, and modern engineering tools of data flow mechanisms in wireless data communication networking.

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Name of the Program: B. Sc. TE-2 yr **Date: 31st March, 2022**
Semester: 2nd Semester **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 **Summer Semester : 2020 - 2021**
Course Number: EEE 4689 **Full Marks: 150**
Course Title: Peripherals and Microprocessor Based Design **Time : 3.0 Hours**

There are **06 (six)** questions. Answer **06 (six)** questions. The symbols have their usual meanings.

1. Briefly describe the 8086 architecture. Explain with proper illustrations. Describe the concept of Pipelining and how does it affect the performance of 8086 computer. **25**
2. For the following Program stored in RAM (Figure: 2(a)) with the help of the given instruction set (Figure :2(b)) Find out the Operational state of each of the Unit of a SAP-1 Computer. Write down the contents of ALU, Register B, Accumulator and Output register after the execution of the program. **25**

0000	00011010
0001	00101011
0010	00110000
0011	01010000
0100	11110000
0101	
0110	
0111	
1000	
1001	
1010	00001000
1011	00001001
1100	
1101	
1110	
1111	

Figure : 2(a)

Instruction	code
Load Address to Accumulator	0001
Load Address to Reg. B	0010
Add	0011
Sub	0100
Output Register	0101
stop	1111
No operation	000

Figure : 2(b)

3. Describe the Adder-Subtraction unit of SAP-I. Illustrate with the operation of selective switch. **25**
4. Write an assembly program that takes two numbers from the user and adds them then shows the summation in the next line. **25**
5. Briefly differentiate between the SAP-I and SAP-II computer with proper **25**

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Illustrations.

6. Describe the *General-Purpose Registers* and *Segment-Offset Registers.* Briefly describe the *Virtual Address* to *Physical Address* conversion. Design an 8-bit Encoder. **25**

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B. Sc. in EEE
8th Semester

04 April, 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 Number: EEE 4801
Course Title: Power Generation

Summer Semester: 2020 - 2021
Full Marks: 150
Time: 3.0 Hours

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

1. a) Write a short note on the generation of electrical energy. **(5)** (CO1) (PO1)

   b) Define a steam power station and explain the factors taken into account while selecting the site for a steam power station. **(10)** (CO2) (PO2)

   c) A diesel engine power plant has one 700 kW and two 500 kW generating units. The fuel consumption is 0·25 kg per kWh and the calorific value of fuel oil is 10000 kcal/kg. Estimate (i) the fuel oil required for a month of 30 days and (ii) overall efficiency. Plant capacity factor is 40%. **(10)** (CO3) (PO3)

2. a) Explain the terms load factor and diversity factor. **(5)** (CO1) (PO1)

   b) Discuss the advantages of interconnected grid system. **(10)** (CO2) (PO2)

   c) A generating station is to supply four regions of load whose peak loads are 10 MW, 5 MW, 8 MW and 7 MW. The diversity factor at the station is 1·5 and the average annual load factor is 60%. Calculate: (i) the maximum demand on the station, (ii) annual energy supplied by the station and (iii) suggest the installed capacity and the number of units. **(10)** (CO3) (PO3)

3. a) Explain the effects of high load factor on the operation of power plant. **(5)** (CO1) (PO1)

   b) Discuss the diminishing value method of determining the depreciation of the power plant equipment. **(10)** (CO2) (PO2)

   c) The equipment in a power station costs Tk. 15,60,000 and has a salvage value of Tk. 60,000 at the end of 25 years. Determine the depreciated value of the equipment at the end of 15 years using (i) straight line method, (ii) diminishing value method and (iii) sinking fund method at 5% compound interest annually. **(10)** (CO3) (PO3)

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4. a) Define tariff and write four objectives of tariff. **(5)** (CO1) (PO1)

b) Describe some of the important types of power factor tariff commonly used. **(10)** (CO2) (PO2)

c) The monthly readings of a consumer's meter are as follows: maximum demand = 50 kW, energy consumed = 36,000 kWh and reactive energy = 23,400 kVARh. If the tariff is Tk. 80 per kW of maximum demand plus 8 paise per unit plus 0·5 paise per unit for each 1% of power factor below 86%, calculate the monthly bill of the consumer. **(10)** (CO3) (PO3)

5. a) Explain the causes of low power factor of the supply system. **(5)** (CO1) (PO1)

b) Derive an expression for the most economical value of power factor which may be attained by a consumer. **(10)** (CO2) (PO2)

c) A factory has an average demand of 50 kW and an annual load factor of 0·5. The power factor is 0·75 lagging. The tariff is Tk. 100 per kVA of maximum demand per annum plus 5 paise per kWh. If loss free capacitors costing Tk. 600 per kVAR are to be utilised, find the value of power factor at which maximum saving will result. The interest and depreciation together amount to 10%. Also determine the annual saving effected by improving the p.f. to this value. **(10)** (CO3) (PO3)

6. a) Explain that the electrical energy preferred over other forms of energy. **(5)** (CO1) (PO1)

b) Explain with a neat sketch the various parts of a nuclear reactor. **(10)** (CO2) (PO2)

c) The daily load duration curve for a typical heavy load being served by a combined hydro-steam system may be approximated by a straight line; maximum and minimum loads being 60,000 kW and 20,000 kW, respectively. The hydro power available at the time of minimum regulated flow is just sufficient to take a peak load of 50,000 kWh per day. It is observed that it will be economical to pump water from tail race to the reservoir by utilizing the steam power plant during the off-peak periods and thus running the station at 100% load factor. Determine the maximum capacity of each type of plant. Assume the efficiency of steam conversion to be 60%. **(10)** (CO3) (PO3)

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B.Sc. Eng. EE, 8th Semester April 13, 2022

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

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Final Examination — Summer Semester, A. Y. 2020-2021
Course No. : Hum 4821 — Time : 3 Hours
Course Title : Business Communication Skill — Full Marks : 150

Answer all 6 (six) questions. All questions carry equal marks. Figures in the margin indicate full marks. Do not write on this question paper.

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1. a) "Communication skill is called a number one skill to be a successful businessman". Do you agree with this statement? Put your logic. 7

   b) Recall a time when you experienced a problem as a result of poor communication. What were the causes and possible remedies of that problem? 8

   c) Body positions and movements are major form of non-verbal communication. Explain these nonverbal communications first and then explain how communicating across cultures varies significantly while using these nonverbal communications. Use real-life examples to answer this question. 10

2. a) "Some short words are hard, and some long words are easy. Thus, the suggestion to prefer short words doesn't make sense." Discuss. 10

   b) The Board of Directors of M/S Bajaj Auto Ltd. met and decided to make certain adjustments in the existing staff of its Akurdi plant. After the meeting, the Managing Director informally told his Secretary that there may be changes in the staffing pattern of Akurdi plant. The Secretary told her friends during lunch break that the plant would soon be laying off employees. Even though, she took a promise that they will not tell anybody, her friends sounded some employees of the plant about the impending danger. The employees union not only presented memorandum to the authorities but served a notice to go on strike also. 15

   Questions

   I. Identify the barriers of communication in the case.
   II. Was there any encoding and decoding of message?
   III. What lessons do you draw from the issue by assuming you as the Managing Director?

3. a) The more effectively you listen, the more effectively you communicate about engineering risk and cost. However, only about 25% of listeners grasp the central ideas in business communications. To improve listening skills, which issues will you consider? 10

   b) As an interviewee, you want to impress the members of your interview board. In this regard, what guidelines do you need to follow during the interview? Write your answer concisely. 15

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4. Assume, after graduation you want to start-up an IT company, accordingly you have made related basic decisions. Based on your plan, preparation and theoretical knowledge, critically examine generation of a new business idea. 25

5. a) On a recent trip to India, Mr. Yang, a prominent Chinese executive, dined with his client Himanshu Jain. Mr. Yang commented that the food was spicy, which Mr. Jain interpreted as an opportunity to discuss Indian cuisine. After lengthy explanations, Mr. Yang commented again that the food was spicy. What happened here? What barrier is likely getting in the way of clear communication? 8

   b) "The you-viewpoint is dishonest. It's unethical". Do you agree with this statement? Put your logic. 7

   c) What do you mean by 'being sincere' in communication? How can you show sincerity in your write-up? Discuss. 10

6. a) Assume that very recently you have completed B.Sc. from Dhaka Technical University Bangladesh. Now you are looking for a job. An advertisement for recruiting some third level engineer at Proctor and Gamble (P&G) is published at Bangladesh Times. Write an application to Human Resources Director of the company seeking the job. Also assume that a specialized resume will accompany the application. To prepare the resume any hypothetical qualification/experience is allowed. 20

   b) In interview what things do you need to know about yourself and your prospective employer? 5

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Name of the Program: B. Sc. in EEE **Date: 11 April, 2022**
Semester: 8th **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 **Summer Semester : 2020 - 2021**
Course Number: Phy 4821 **Full Marks: 100**
Course Title: Engineering Materials **Time : 3.0 Hours**

There are **08 (eight)** questions. Answer any **06 (six)** questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

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1. a) Define the temperature coefficient of resistivity (TCR)? Derive the expression of thermal resistance, θ. **(4) (CO1) (PO1)**

b) Estimate the drift mobility of electrons and the conductivity of copper. Given that the speed of conduction electrons in copper is $1.5 \times 10^6 ms^{-1}$ and the frequency of vibration of the copper atoms at room temperature is about $4 \times 10^{12} s^{-1}$. The density d of copper is $8.96 gcm^{-3}$ and the atomic mass is $63.56\ gmol^{-1}$. **(6) (CO1) (PO4)**

c) Explain the Heisenberg's uncertainty principle? Apply Heisenberg's principle for a free electron to find out the uncertainty in position and momentum. **$(6\frac{2}{3})$ (CO2) (PO1)**

2. a) Consider a step potential function, having a height V_0. A particle with energy $E > V_0$ is incident from $+x$ direction travelling in the $-x$ direction.
   i. Determine the solutions of each region.
   ii. Derive expressions for the transmission and reflection coefficient.
$(10\frac{2}{3})$ (CO2) (PO1)

b) Consider two copper wires separated by a 5 nm thick oxide layer, which is a potential barrier of height 10 eV. Calculate the transmission coefficient for conduction electrons in copper, which have a kinetic energy of about 7 eV. Determine the transmission coefficient if the oxide barrier is 1 nm ? **(6) (CO2) (PO5)**

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3. a) Derive the expression for electronic wavefunctions and energies for a potential box. Calculate the number of the degenerate states available in energy levels E_{321} and E_{443} for a square potential box. (8) (CO3) (PO2)

b) The average intensity of sunlight on Earth's surface is about $1\ kW\ m^{-2}$. The maximum intensity is at a wavelength around 800 nm. Assuming that all the photons have an 800 nm wavelength, $(8\frac{2}{3})$ (CO3) (PO4)

i. Calculate the number of photons arriving on Earth's surface per unit time per unit area.

ii. Determine the magnitude of the electric field in the sunlight.

iii. Suppose that a solar cell device can convert each sunlight photon into an electron that can then give rise to an external current. Calculate the maximum current that can be supplied per unit area (m^2) of this solar cell device.

4. a) Explain the origin of complexity in relative permittivity. Derive the expression for loss tangent. (8) (CO4) (PO1)

b) Derive the prove of Clausius-Mossotti equation. Justify a few applications of this equation. $(8\frac{2}{3})$ (CO4) (PO1)

5. a) Explain the formation of Copper pair in BCS theory of superconductor. (5) (CO6) (PO1)

b) The application of stress T to a piezoelectric crystal leads to a polarization P and hence to an electric field E in the crystal such that (6) (CO4) (PO1)

$$E = gT,$$

where g is the piezoelectric voltage coefficient? If $\varepsilon_r\varepsilon_0$ is the permittivity of the crystal, show that

$$g = \frac{d}{\varepsilon_r\varepsilon_0}$$

c) A $BaTiO_3$ sample, along a certain direction, has $d = 190\ pCN^{-1}$, and its $\varepsilon_r \approx 1900$ along this direction. Calculate its expected value for the g coefficient along this direction and how this compares with the measured value of approximately $0.013\ m^2C^{-1}$. $(5\frac{2}{3})$ (CO4) (PO4)

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6. a) Show that the local field is given by (6) (CO4) (PO1)

$$E_{loc} = E\left(\frac{\varepsilon_r + 2}{3}\right)$$

b) Amorphous selenium (a-Se) is a high resistivity semiconductor that has a density of approximately 4.3 gcm^{-3} and an atomic number and mass of 34 and 78.96 g/mol respectively. Its relative permittivity at 1 KHz has been measured to be 6.7. Calculate the relative magnitude of the local field in a-Se. Calculate the polarizability per Se atom in the structure. What type of polarization is this? How will ε_r depend on the frequency? ($10\frac{2}{3}$) (CO4) (PO4)

7. a) Show that the magnetic susceptibility of nickel given below is constant with the Curie-Weiss law $\left[\chi_m = \frac{C}{T-T_C}\right]$, where χ_m is the magnetic susceptibility, C is Curie constant, T_C is Curie temperature. Evaluate the Curie constant and temperature (C and T_c). Also find the effective number of Bohr magnetons per atom. [Atomic weight of nickel = 58.7, density = 8850 $kg\ m^{-3}$] ($10\frac{2}{3}$) (CO5) (PO5)

$T(^0C)$	500	600	700	800	900
$\chi_m(\times 10^5)$	38.4	19.5	15	10.6	9.73

b) Discuss on Meissner effect. Define penetration depth. Briefly explain Type I and Type II superconductors. (6) (CO6) (PO1)

8. a) Classify and describe different types of magnetic materials. (5) (CO5) (PO1)

b) Samples of Bi $\left(\chi_m = -16.6 \times 10^{-5}\right)$ and Al $\left(\chi_m = 2.3 \times 10^{-5}\right)$ are subjected to an applied magnetic field of 1.0 T in $+x$ direction. Calculate M and $\mu_0 M$ in each sample. Determine which is paramagnetic and which is diamagnetic? ($6\frac{2}{3}$) (CO5) (PO4)

c) Describe metamaterials as oppose to a natural materials. Explain why "double negative" materials are so special? Give some real life examples. (5) (CO6) (PO1)

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B. Sc. in EEE
Semester: 8th

6 April, 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: EEE 4833
Course Title: HVDC Power Transmission

Summer Semester: 2020 - 2021
Full Marks: 150
Time: 3.0 Hours

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

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1. a). With neat schematic diagram, state various apparatus required for HVDC station and explain the purpose of each. (10) (CO1) (PO1)

   b). The AC line voltage is 330 kV with a load of 500 MW and power factor 0.78 at the inverter end. Calculate the AC line voltage, current and power factor at the rectifier end with $\mu = 15°$. (15) (CO2) (PO2)

2. a). Explain the typical valve arrangements in HVDC converters using thyristor. How is triggering, protection and voltage equalization during switching achieved? (10) (CO1) (PO1)

   b). An HVDC link delivers DC power with AC line voltage to the rectifier being 400 kV and that at the inverter being 392 kV. Assume $\alpha = 10°$, $\gamma = 15°$. The DC resistance of the line is 20 Ω. Calculate: (15) (CO2) (PO2)
   i. the DC voltage at both ends
   ii. The current in the DC link
   iii. The power delivered
   iv. Losses in the link

3. a). With neat sketches, explain how a converter transformer is responsible for generation of harmonics and suggest various methods for minimizing them. (10) (CO1) (PO1)

   b). Sketch the waveforms of the output voltage and transformer secondary current in case of 3-phase, 6 pulse bridge circuit (Graetz's circuit) for $\alpha = 30°$, and $\alpha = 120°$. (15) (CO2) (PO2)

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4. a). Illustrate the schematic diagram and layout of harmonic filters on the AC side of an HVDC system. (10) (CO1) (PO1)

b). Derive an expression for resistance of hemispherical electrode of radius, *a*, situated in non-uniform earth of resistivity ρ_1 and ρ_2 ($\rho_2 > \rho_1$) as shown in Fig. 4(b). (15) (CO1) (PO1)

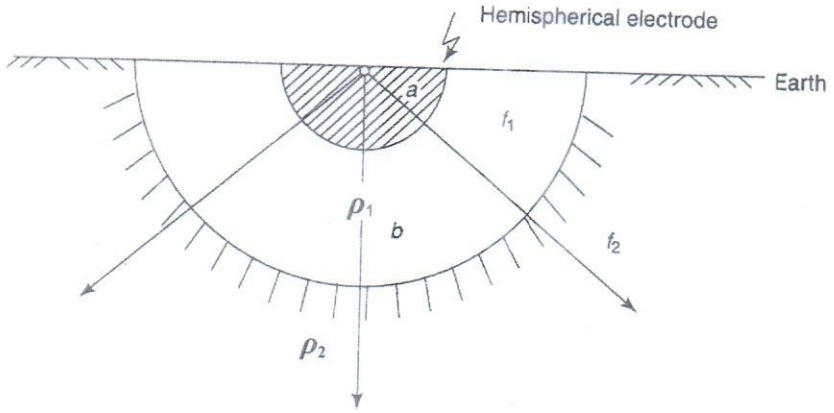

Fig. 4(b)

5. a). State the main types of faults in converters and converter stations. (10) (CO1) (PO1)

b). Design a DC circuit breaker suitable to interrupt DC current. Illustrate the purpose of surge arrestor used across the DC circuit breaker. (15) (CO3) (PO3)

6. a). Discuss the equivalent circuit of DC insulator string and explain the significance of different components. How is the nature of the voltage distribution across the string? (15) (CO1) (PO1)

b). How do the following material properties dictate the electrical field distribution in the insulator of a DC cable and AC cable? (10) (CO1) (PO1)

i. conductivity of the material.
ii. permittivity of the material.

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Name of the Program: B.Sc. in EEE
Semester: 8th

Date: 28 March, 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 4841
Course Title: Microwave Engineering

Summer Semester : 2020 - 2021
Full Marks: 150
Time : 3.0 Hours

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

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1. **(a)** Show the following expressions for voltage v and current i on an ideal transmission line with characteristic impedance, Z_0 and phase velocity, v_p. **(12) (CO1, PO1)**

$$v(z,t) = f_1\left(t - \frac{z}{v_p}\right) + f_2\left(t + \frac{z}{v_p}\right)$$

$$i(z,t) = \frac{1}{Z_0}\left[f_1\left(t - \frac{z}{v_p}\right) - f_2\left(t + \frac{z}{v_p}\right)\right].$$

(b) The first voltage minimum is located 1.875 cm from the load. The load impedance is Z_L = j100 Ω. The operating frequency is 6 GHz. Calculate VSWR and the characteristic impedance of the transmission line. **(13) (CO2, PO2)**

2. **(a)** Show that the propagation constant, $\gamma = \sqrt{(R + j\omega L)(G + j\omega C)} = \alpha + j\beta$, where $V(z) = Ve^{-\gamma z}$ represents the voltage wave equation for lossy transmission line. Mention the significance of the attenuation constant, α. **(12) (CO1, PO1)**

(b) Someone wants to use a double-stub shunt tuner to match a load using short-circuited stubs. The load impedance is 18+j18 Ω. The characteristic impedance of the line is 50 Ω. The spacing between stubs is 5λ/16. Determine the result of this design approach. **(13) (CO2, PO2)**

3. **(a)** The characteristic impedance of a transmission line is Z_0 = 50 Ω. Design a quarter-wave transformer to match load impedance 85 + j80 Ω. The operating frequency is 6 GHz. Show any length or distance in cm. **(13) (CO3, PO3)**

(b) The cut-off frequency of TE_{04} mode of a rectangular waveguide is 5 times higher than the cut-off frequency of its dominant mode. Calculate the ratio of width and height for the waveguide. **(12) (CO2, PO2)**

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4. (a) The cut-off frequency of the dominant mode of a circular waveguide is 2.93 GHz. This waveguide uses only modes higher than TM_{12} mode. The waveguide does not use any modes higher than TE_{03} mode. Calculate the operating bandwidth of the waveguide. Use Table 1. **(12) (CO2, PO2)**

	Roots of Bessel Function				Roots of Derivative of Bessel Function			
n	ρ_{n1}	ρ_{n2}	ρ_{n3}	ρ_{n4}	ρ'_{n1}	ρ'_{n2}	ρ'_{n3}	ρ'_{n4}
0	2.4	5.52	8.66	11.79	3.83	7.02	10.17	13.32
1	3.83	7.02	10.17	13.32	1.84	5.33	8.54	11.71
2	5.14	8.42	11.62	14.77	3.05	6.71	9.97	13.17
3	6.38	9.76	13.02	16.22	4.2	8.015	11.35	14.59
4	7.56	11.06	14.37	17.62	5.32	9.28	12.68	15.96

Table 1

(b) Design a coaxial line with characteristic impedance 50 Ω and power capability up to 400 kW. Determine the operating bandwidth of your design. **(13) (CO3, PO3)**

5. (a) The specifications of a transistor are given as $S_{11} = 0.95\angle{-140^0}$, $S_{21} = 2.4\angle{50^0}$, $S_{12} = 0$ and $S_{22} = 0.8\angle{-65^0}$. Determine if an amplifier based on this transistor will be stable for load impedance $Z_L = 75 + j80\ \Omega$ and characteristic impedance $Z_0 = 50\ \Omega$. Consider the output side only to determine the stability. **(12) (CO2, PO2)**

$$C_L = \frac{(S_{22} - \Delta S_{11}^*)^*}{|S_{22}|^2 - |\Delta|^2} \qquad R_L = \left|\frac{S_{12}S_{21}}{|S_{22}|^2 - |\Delta|^2}\right|$$

$$|\Delta| = |S_{11}S_{22} - S_{12}S_{21}|$$

(b) The specifications of a transistor are given as $S_{11} = 0.61\angle{-170^0}$, $S_{21} = 2.24\angle{32^0}$, $S_{12} = 0$ and $S_{22} = 0.72\angle{-83^0}$. For an amplifier with constant gain, the part of the gain in the output side, $G_L = 2$ dB. Design the amplifier drawing the output section of the amplifier stage. **(13) (CO3, PO3)**

$$C_L = \frac{g_L S_{22}^*}{1 - (1 - g_L)|S_{22}|^2} \qquad R_L = \frac{\sqrt{1 - g_L}(1 - |S_{22}|^2)}{1 - (1 - g_L)|S_{22}|^2}$$

$$G_{Lmax} = \frac{1}{1 - |s_{22}|^2}$$

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6. (a) The specifications of a transistor are given as $S_{11} = 0.6\angle -60^0$, $S_{21} = 2\angle 81^0$, $S_{12} = 0$ and $S_{22} = 0.7\angle -60^0$. Calculate the reflection coefficient at the input port of the transistor stage, ρ_i when the load impedance is $150 - j25\ \Omega$. **(12) (CO2, PO2)**

(b) The specifications of a transistor are given as $S_{11} = 0.6\angle -60^0$, $S_{21} = 2\angle 81^0$, $S_{12} = 0$ and $S_{22} = 0.7\angle -60^0$, $F_{min} = 2$ dB, $\rho_{opt} = 0.62\angle 100^0$ and $R_N = 20\ \Omega$. The tolerable noise figure, F = 2.2 dB. For gain circles at the input, use $C_S = 0.44\angle 60^0$ and $R_S = 0.44$. Design the low noise amplifier (LNA) giving the possible ρ_S values. The characteristic impedance is $Z_0 = 50\ \Omega$. The operating frequency is 6 GHz. **(13) (CO3, PO3)**

$$C_F = \frac{\rho_{opt}}{N+1} \qquad R_L = \frac{\sqrt{N\left(N+1-|\rho_{opt}|^2\right)}}{N+1}$$

$$N = \frac{F - F_{min}}{4\,{}^{R_N}/_{Z_O}}\,|1+\rho_{opt}|^2$$

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Name of the Program: B. Sc. in EEE
Semester: 8th Sem.

Date: 06 April, 2022
Time: 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 — **Summer Semester : 2020 - 2021**
Course Number: EEE 4851 — **Full Marks: 150**
Course Title: Advanced Communication Techniques — **Time : 3.0 Hours**

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

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1. a) Assuming that the starting frequency of a band is given by f_{st}. Derive the received UWB power to the NB power ratio as a function of bandwidth W and the starting frequency. — 10 — CO2, PO2

   b) Describe the reason that conventional or ad-hoc routing protocols cannot be used for wireless sensor network (WSN). Deduce the energy consumption if 1 Mbit of information is transferred from the source to the sink where the source and sink are separated by 100 meters and the broadcast radius of each node is 5 meters. Assume the neighbor nodes are overhearing each other's broadcast. — 10

   c) For a wireless Rayleigh fading channel, consider a transmit power P_t (dB) = 20 dB. Calculate the probability that the power at the receiver is greater than P_r (dB) = 10 dB. — 5

2. a) Explain MIMO Zero-Forcing (ZF) receiver operation. — 10 — CO1, PO1

   b) In figure 2(b), node S wants to send a packet to node D. Explain route discovery in dynamic source routing (DSR) for the following nodes: — 5

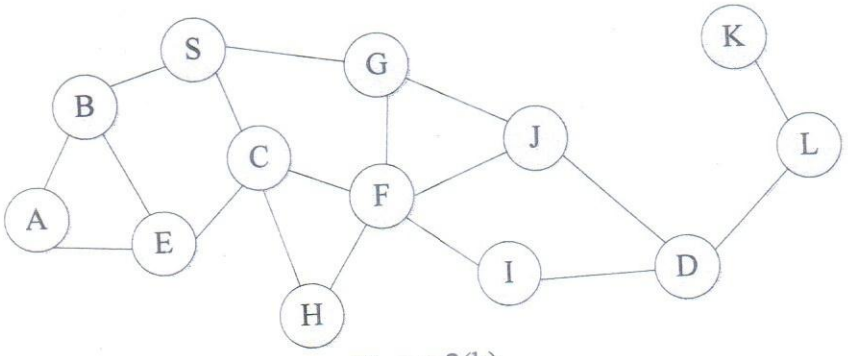

Figure 2(b).

   c) With detailed derivation, explain the concept of Orthogonal Frequency Division Multiplexing (OFDM). — 10

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3.	a)	Develop models for fading channel coefficient, h. Explain center limit theory.	10	CO1, PO1
	b)	Consider an L = 2 receive antenna wireless channel with complex fading channel coefficients $h_1 = \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}j$, $h_2 = \frac{1}{\sqrt{2}} - \frac{1}{\sqrt{2}}j$. Describe the system model for the multi-antenna channel and derive the SNR with MRC.	10	
	c)	Consider a multiple-input single-output (MISO) wireless system like the SIMO system. Formulate the system model for the received signal at the receiver of an L antenna MISO system, i.e., one which has L transmit antennas and a single receive antenna.	5	
4.	a)	Consider a Rayleigh fading-channel-based wireless system such that $\{\|h\|^2\} = 1$, where h is the flat-fading channel coefficient. If the transmit power P_t(dB) = 25 dB, calculate the probability that the received power is greater than 20 dB. Compute the same for a received power of 10 dB.	10	CO2, PO2
	b)	Explain the design challenges of a wireless sensor network (WSN). Determine how many sensor nodes are needed within a broadcast radius (range) to have 99% fault tolerated network? Assuming all sensors within the radio range has same reliability.	5	
	c)	Assume some sensor nodes are evenly distributed in the sensor field, determine the node density if 200 sensor nodes are deployed in a 50×50 m^2 region where each sensor node has a broadcast radius of 5 m.	10	
5.		Explain the followings: i) Energy efficient routing, ii) Ultra wide-band communication system, iii) Diversity, iv) Low-energy adaptive clustering hierarchy (LEACH).	25	CO3, PO3
6.	a)	Derive the average BER for BPSK in a Rayleigh fading channel.	10	CO2, PO2
	b)	Derive the probability of a deep-fade event in a wireless communication system.	10	
	c)	Compute the MIMO zero-forcing receiver for the channel matrix H given as	5	

$$H = \begin{bmatrix} 2 & 3 \\ 1 & 3 \\ 4 & 2 \end{bmatrix}$$

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B. Sc. in EEE
8th Semester

28 March, 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 Number: EEE 4865
Course Title: Digital Filter Design

Summer Semester : 2020 - 2021
Full Marks: 150
Time : 3.0 Hours

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

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1. (a) Compare between Butterworth and Chebyshev filter with proper diagram and example. **(10)** (CO1) (PO1)

   (b) Design a Chebyshev low-pass-filter for the following specifications: **(15)** (CO2) (PO3)
   Pass-band gain required: 0.84,
   Frequency up to which pass-band gain must remain more [illegible] 150 rad/s,
   Amount of attenuation required: 0.0316,
   Frequency for which the attenuation must start: 300 rad/s.

2. (a) Derive the transfer function of a fifth order Butterworth filter. **(10)** (CO2) (PO1)

   (b) For the derived transfer function in 2. (a), develop the circuit diagram with all the values of resistors and capacitors using Sallen-Key approach. **(15)** (CO2) (PO3)

3. (a) Explain the steps of the Bilinear Transformation for the IIR filter design. **(10)** (CO2) (PO1)

   (b) How can you solve the design challenges for Band Pass filter when you follow frequency transformation? Explain it with an example. [Hints: The center frequency, lower cutoff and the higher cutoff are given from the customer. Now, how can you achieve those parameters in practice?] **(15)** (CO3) (PO2)

4. (a) Compare between Hanning, Hamming and Blackman window with magnitude spectrum and discuss it. **(10)** (CO3) (PO2)

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(b) Design a FIR low-pass filter using frequency-sampling method from the specifications given below: **(15)** (CO2) (PO3)

Frequency of pass-band edge: 450 Hz,
Stop-band starts at: 750 Hz,
Sampling frequency: 2500 Hz,
Order of the filter: 8.

5. (a) Design a low-pass FIR filter using Kaiser's approach for the following specifications: **(15)** (CO2) (PO3)

Frequency of pass-band edge: 2500 Hz,
Gain in pass-band: -1 dB,
Frequency from which stop band begins: 3500 Hz,
Gain in stop band: -55 dB,
Sampling frequency: 15000 Hz.

Formula related to Kaiser's Approach:

$$\alpha = 0.1102\,(H_{2m} - 8.7), \qquad H_{2m} > 50$$

$$= 0.5842(H_{2m} - 21)^{0.4} + 0.07886(H_{2m} - 21), \qquad 21 \le H_{2m} \le 50$$

$$= 0.00 \qquad H_{2m} < 21$$

$$M = \frac{N}{2} = \frac{H_{2m} - 7.95}{2.285(\Delta\omega)}$$

$$I_0(x) = \frac{0.3989e^x}{\sqrt{x}}\left(1 + \frac{1}{8x} + \frac{9}{128x^2}\right)$$

$$W_{KAI}(n) = \frac{I_0[\alpha\sqrt{1-(n/M)^2}]}{I_0(\alpha)}, \qquad -M \le n \le M$$

(b) Based on frequency warping and prewarping, present the magnitude spectrum for both actual and relative frequency spectrum. **(10)** (CO2) (PO1)

6. (a) For type-IV FIR filter show that it contains zero at $Z = +1$. What kind of filter may be designed by this type of filter? Explain it with magnitude response. **(15)** (CO3) (PO2)

(b) For a 7th order FIR linear phase filter, two of the zeros are located at $Z = 0.2e^{j(\pi/4)}$ and $Z = j$. Find the other zeros and plot it in the Z-plane. **(10)** (CO3) (PO2)

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B.Sc. TE (2-Yr), B.Sc. TE (1-Yr) **March 28, 2022**
Semester: Summer **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 **Summer Semester: 2020-2021**
Course No.: EEE 4891 **Full Marks: 150**
Course Title: Medical Electronics **Time: 3 Hours**

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

1.	a)	What is biopotential electrode? Mention different types of electrodes with proper diagram.	10
	b)	Write short descriptions on the following topics of biopotential electrode: (i) Standard Electrode Potential (ii) Double Layer (iii) Electrode-skin interface (iv) Electrode Noise (v) Electrode Stabilization	15
2.	a)	State different types of medical imaging modalities and discuss briefly.	10
	b)	What are the basic waveforms of electroencephalogram? Mention each of them with their significance and frequency band. What is evoked potential? State its classification and discuss briefly.	15
3.	a)	What are the properties of ideal pre-amplifier? Draw the EMG block diagram for both analog and digital cases.	10
	b)	Describe mechanism of cardiac tachometer elaborately by drawing appropriate circuit and block diagram.	15
4.	a)	What is noise cancelling technique? Draw the responses of different components for both high frequency and low frequency behavior.	10
	b)	What is interference? Discuss the coupling mechanism for the capacitive case in terms of interference.	15
5.	a)	What do you understand by "Wired Bio-telemetry"? What are the components of it? Explain the process of wired-bio telemetry with proper block diagram.	10
	b)	Classify telemetry based on modulation method. Explain the following: (i) Direct Current Telemetry (ii) Single Channel PCM Telemetry (iii) Single Channel PWM Telemetry	15
6.	a)	How can you obtain the ECG of a fetus from mother's ECG? Describe the process by drawing appropriate circuit diagram.	10
	b)	What is instrumentation amplifier? State its features and draw the circuit diagram by mentioning various stages.	15

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7	a)	What is "patient monitoring"? Describe the patient monitoring system in ICU.	10
	b)	Draw the circuit diagram of bed side monitoring system and mention the measuring parameters.	15
8	a)	Write short descriptions on the following topics: i) Effect of motion artefact to the signal ii) Electrical requirements for electrodes iii) Practical aspects of biopotential electrodes iv) Thermal Noise v) Sources of noise and interference in bioelectrical measurements	25

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

Date :6th April 2022
Time: 10:00 am – 1:00 pm

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

Semester Final Examination
Course No. EEE 4895
Course Title: Power Station

Summer Semester A.Y.2020-2021
Time: 3 Hours
Full Marks: 150

There are eight (8) questions. Answer any six (6) questions briefly and concisely. Use figures, charts, equations and state examples where necessary to clarify your answers. All questions carry equal marks. Figures in the right margin indicate marks of each question. All symbols preserve their usual meanings.

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1 a) Energy sources can broadly be classified as being renewable or nonrenewable in nature. Define each of the underlined terms as referred to energy sources, stating two examples in each case. **8**

b) With the help of a well labeled diagram or chart, explain how electricity is generated from any renewable or nonrenewable energy source in your country. **12**

c) Distinguish between the processes of solar energy conversion by photovoltaic cells and that by plants during photosynthesis. **5**

2 a) State and explain the four (4) steps to be followed to obtain the maximum average input required by a steam plant operating within 10% to 100% maximum load, having a load factor other than 1 with a varying capacity factor. **10**

b) A steam power station can be summarized by the flow chart below **15**

Input ⟶ Boiler ⟶ Steam turbine ⟶ Generator ⟶ Gross load

Where the input (I) is fuel, the output of the boiler is (O) and the gross load is Lg = A + Ln (A is the auxiliary demand and Ln is the net demand).

Show that $R_{st} = R_b \times R_t \times (1/(1-R_a))$.

Where R_{st} is the station incremental rate, R_b is the boiler incremental rate R_t is the turbo generator incremental rate and Ra is the auxiliary demand rate.

3. a) i) Distinguish between the maximum demand and the connected load as applied to consumers of electrical power. **4**

ii) State why the maximum demand should not exceed the connected load. **2**

b) i) Explain how a load energy curve could be obtained from a load duration curve. **4**

c) Table 1 below shows the daily load consumption of a consumer group: **15**

Table 1

Period (In Hours)	Load (KW)
0 - 6	40
6 - 12	20
12 - 18	15
18 - 24	10

i) Draw the load duration curve of the consumer group.

ii) Obtain the load energy curve from the load duration curve from 3(c)(i),

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4 a) Briefly describe the operation of following types of stations, stating clearly how fuel and water resources are being utilized in each case. **15**

i) A hydraulic station
ii) A thermal station
iii) A hydro-thermal station

b) Using clear diagrams, explain how load demand can be fulfilled in a hydro-thermal station during the following seasons: **10**

i) Monsoon
ii) Dry season

5 a) With the help of appropriate curves, define the heat rate and the incremental heat rate of a power station. **6**

b) Using the definitions in 5 (a), show that the heat rate and the incremental heat rate are equal. **6**

c) The input-output of a 20MW station is expressed as; **13**

$$I = 30 + 0.5L + 0.65L^2 + 0.01L^3$$

Where, I is in millions of BTU/hours and L is in MW. Find out the increase in input for an increase of load from 7MW to 9MW

i) using the input-output curve.
ii) using the incremental heat rate curve.

6 Write short notes on any four (4) of the following. **25**

i) Energy crisis (in a country)
ii) Commercial energy sources
iii) Utility factor (of a power station)
iv) Capacity factor
v) Demand factor
vi) Load shading

7 a) With the help of a flow diagram, explain the four main energy conversion stages in a hydroelectric power station. **7**

b) State and explain any four (4) advantages and any four (4) disadvantages of a hydroelectric power station to the environment and human settlements. **16**

c) Explain why electric power is transmitted at high voltage and low current rather than high current and low voltage. **2**

8 a) Define the term "energy rate". **2**

b) State and explain any four (4) types of energy rates **8**

c) A step meter rate is quoted as follows **15**

0 – 10 kWhr at 10 cents per kWhr
10 – 50 kWhr at 8 cents per kWhr
50 – 100 kWhr at 6 cents per kWhr
Over 100 kWhr at 5 cents per kWhr

Convert the above step meter rate to a modified meter rate.

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M.Sc.Engg/ (MSc.TE)
PhD

29 March 2022 (Group B)

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

Semester Final Examination
Course No. MCE 6153
Course Title: Boiling and Condensation Heat Transfer

Summer Semester, A.Y. 2020-2021
TIME : 3 hours
Full Marks : 150

Answer all the questions.

1	(a) Briefly describe the Hydrodynamic Theory of Boiling and Critical Heat Flux for *a horizontal flat surface.*	10
	(b) Briefly describe the various *regimes* of *Nucleate boiling* observed during pool boiling in *Binary liquid mixtures.*	8
	(c) Elaborate the terms: *Minimum film boiling* and *Transition boiling.*	7
2	(a) With a diagram, demonstrate *Flow patterns* and *temperature variation* in subcooled flow boiling. Draw the *boiling curve* at the vicinity of the subcooled boiling region.	10
	(b) Elucidate the effects of *local quality* and *mass flux* on the flow boiling curve for a *vertical pipe.*	8
	(c) What are the *Characteristics* of *Saturated Flow Boiling?*	7
3	(a) Describe the *Critical Heat Flux* mechanism in forced flow boiling. Describe the three different phenomenological arguments to model the *Critical Heat Flux* mechanism.	13
	(b) Explain the effect of *mass flux* and *exit quality* on critical heat flux in a uniformly heated *round tube.*	12
4	(a) Describe *Nusselt's analysis* of *Laminar condensation* on an *isothermal flat vertical surface.*	10
	(b) Describe the phenomenon of *Laminar condensation* on *Horizontal tubes.*	8
	(c) Explain the effect of the *Presence of a Noncondensable* during the condensation process.	7
5	(a) Describe the *Heterogeneous Bubble Nucleation and Active Nucleation Sites* observed in Pool boiling.	10
	(b) Describe the phenomenon of *transition* from *partial boiling* to fully developed *subcooled boiling.*	8
	(c) Write short notes on *Hydrodynamics of Subcooled Flow Boiling.*	7
6	(a) Explain the effect of *Diameter* on critical heat flux in forced flow boiling for small channels.	10
	(b) Briefly discuss the various flow regimes of *Post-Critical Heat Flux Heat Transfer*	8
	(c) Elucidate *Film, Dropwise,* and *Direct contact Condensation Process.*	7

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M.Sc. TE (2 year), 2nd Sem. Date: March 29, 2022

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

Final-Semester Examination
Course Number: **EEE 6297**
Course Title: **Microwave Engineering**

Summer Semester: 2020 - 2021
Full Marks: 150
Time: 3 hours

There are **08 (eight)** questions. Answer **any 06 (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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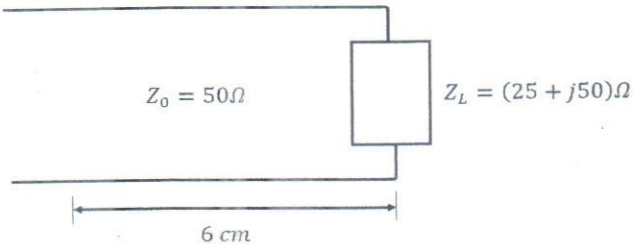
1. (a) The incident voltage and the reflected voltage on an ideal transmission line are given by $|V_+|\cos\omega(t-\frac{z}{v_p})$ and $|V_-|\cos[\omega(t+\frac{z}{v_p})+\theta_p]$, respectively. Derive an expression for reflection coefficient at the point of load in terms of characteristic impedance and load impedance. Also, show that the phase change of incident wave up to the position of minimum voltage amplitude from the point of load is as follows, [12]

$$\beta l_{\min} = \frac{\theta_p}{2} + (2n+1)\frac{\pi}{2} \quad \text{where n=-1, 0, 1, 2, 3, ...}$$

(b) The load $Z_L = 25 + j50$ is connected to an ideal transmission line with characteristic impedance $Z_0 = 50\Omega$. The incident voltage is $V_+ = 10\angle 0^0$ V at the point of load. Determine the total current at the point of load. Also, determine the reflected voltage and reflected current at a point 6 cm away from the load. The operating frequency is 3 GHz. [13]



2. (a) What is the usual frequency range that microwave engineers work with? Draw the configuration of a strip line. [5]

(b) Prove the following relationship for a transmission line. [7]

$$\frac{V_{\max}}{I_{\max}} = \frac{V_{\min}}{I_{\min}} = Z_0$$

(c) The S parameter of a two-port network are $S_{11} = 0.8\angle -90^0$, $S_{21} = 5.1\angle 80^0$, $S_{12} = 0.3\angle 70^0$ and $S_{22} = 0.62\angle -40^0$. The voltage signal entering port 1 is $V_1^+ = 10\angle 0^0$ V and the voltage signal entering port 2 is $V_2^+ = 5\angle 30^0$ V. Determine the voltage signal leaving port 2. [13]

3. (a) Prove that the same Smith chart can be alternatively used as either impedance Smith chart or admittance Smith chart by simply rotating 180^0 on SWR circle. [7]

(b) Design double-stub shunt tuner in order to match a load. The characteristic impedance of the transmission line is 50Ω. The load impedance is $100 + j40\Omega$. Use short circuited stubs and $\frac{2\lambda}{5}$ spacing between stubs. Show distances and length in terms of λ. [18]

4. (a) Derive the following expression from Maxwell's equation. [7]

$$H_y = -\frac{j}{k_c^2}(\omega\varepsilon\frac{\partial E_z}{\partial x} + \beta\frac{\partial H_z}{\partial y}).$$

(b) Explain briefly why two-wire lines must be used in order to support TEM wave. [6]

(c) Derive the field equations for TM wave in parallel plate waveguide. Write down the electric field equations for TM_1 wave and then draw and explain the electric field distribution on Y-Z plane from those equations. [12]

[For TM wave, $H_x = \frac{j\omega\varepsilon}{k_c^2}\frac{\partial E_z}{\partial y}$, $H_y = -\frac{j\omega\varepsilon}{k_c^2}\frac{\partial E_z}{\partial x}$, $E_x = -\frac{j\beta}{k_c^2}\frac{\partial E_z}{\partial x}$, $E_y = -\frac{j\beta}{k_c^2}\frac{\partial E_z}{\partial y}$]

5. (a) Derive the field equation for TE in rectangular waveguide. Then write down the field equations and draw the field distribution for the dominant mode, TE_{10}. Derive expression for average power flow for TE_{10} mode. [13]

[For TE wave, $H_x = -\frac{j\beta}{k_c^2}\frac{\partial H_z}{\partial x}$, $H_y = -\frac{j\beta}{k_c^2}\frac{\partial H_z}{\partial y}$, $E_x = -\frac{j\omega\mu}{k_c^2}\frac{\partial H_z}{\partial y}$, $E_y = \frac{j\omega\mu}{k_c^2}\frac{\partial H_z}{\partial x}$]

(b) The cut-off frequency for TE_{10} and TE_{01} modes are 4.5 GHz and 7.5 GHz, respectively for a rectangular waveguide. The waveguide is carrying a TE_{10} mode signal where the amplitude of Hz is 5 Amp/m. Determine the average power flow of 6 GHz. [12]

6. (a) A coaxial line has characteristic impedance 50 Ω and it can carry up to 600 kW. Determine its inner and outer radii and its maximum frequency of operation. Assume that an electrical field strength of 3×10^4 V/cm causes breakdown. [13]

(b) The cutoff frequency for the dominant mode is 3 GHz for a circular waveguide. The waveguide will not carry any mode higher than TE_{41}. Determine the maximum bandwidth available for TM_{21} mode signal. [12]

	Roots of Bessel Function				Roots of Derivative of Bessel Function			
n	ρ_{n1}	ρ_{n2}	ρ_{n3}	ρ_{n4}	ρ'_{n1}	ρ'_{n2}	ρ'_{n3}	ρ'_{n4}
0	2.4	5.52	8.66	11.79	3.83	7.02	10.17	13.72
1	3.83	7.02	10.17	13.32	1.84	5.33	8.54	11.71
2	5.14	8.42	11.62	14.77	6.71	6.71	9.97	13.17
3	6.38	9.76	13.02	16.22	8.015	8.015	11.35	14.59
4	7.56	11.06	14.37	17.62	9.28	9.28	12.68	15.96

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7. (a) Show that the reflection coefficients towards load and towards source are required to be conjugate of each other for maximum power transfer. Assume that the characteristic impedance of the transmission line is purely resistive. [10]

(b) Derive the following expression for a transistor based two-port network connected to a load. [15]

$$\rho_i = s_{11} + \frac{s_{12}s_{21}\rho_L}{1 - s_{22}\rho_L}$$

8 (a) A microwave amplifier is designed for a gain of 10 dB. The S parameters of the transistor are $S_{11} = 0.61\angle -170^0$, $S_{21} = 2.24\angle 32^0$, $S_{12} = 0$ and $S_{22} = 0.72\angle -83^0$. The amplifier uses Gs=1dB and GL=2dB. Show the design of the input circuit only for the amplifier using short circuited shunt stubs. [15]

$$C_s = \frac{g_s S^*_{11}}{1-(1-g_s)|S_{11}|^2},\quad R_s = \frac{\sqrt{1-g_s}(1-|S_{11}|^2)}{1-(1-g_s)|S_{11}|^2},\quad G_{s\max} = \frac{1}{1-|S_{11}|^2}.$$

(b) Compare between solid state and microwave tube solutions. Write down advantages and disadvantages of Magnetron. [4]

(c) Differentiate between Hybrid MIC and MMIC. [3]

(d) Show how output power at different ports are available for power input to different ports for Magic Tee. [3]

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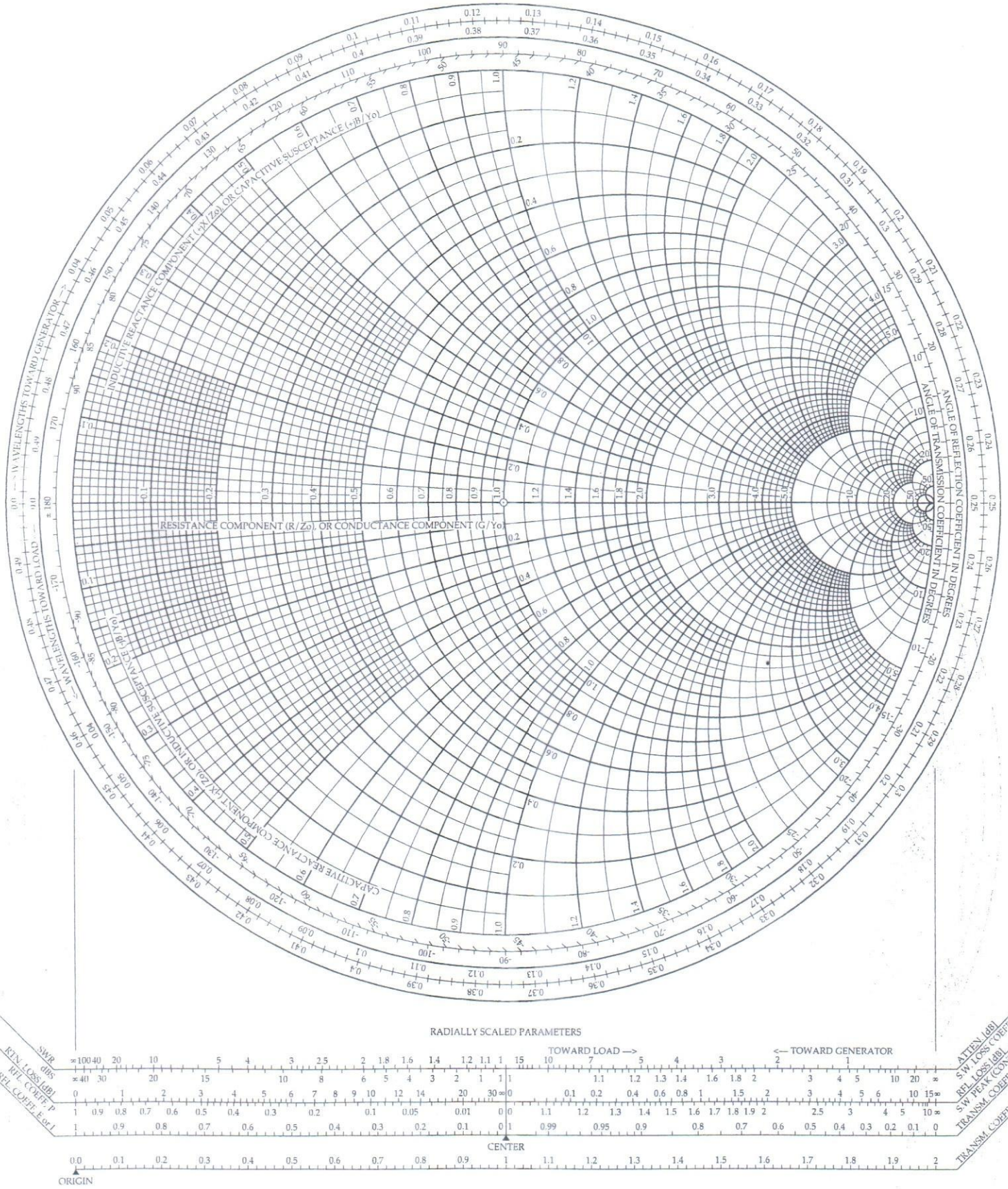
The Complete Smith Chart



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

Date: 01 April, 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. 2020-2021
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) Though the linewidth of the individual laser have 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. 5

2. a) Discuss optical gain characteristic of a LASER. 10

   b) 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. 5

   c) Explain the operation principle of an EDFA. 10

3. a) Draw a schematic diagram of WDM and DWDM light-wave system. What is the important feature of WDM? 5

   b) Derive the noise figure of an optical amplifier. 10

   c) Explain the operation principle of a Raman amplifier. 10

4. a) Compare single-mode and multi-mode fiber. 7

   b) Using Snell's law for air-core media, derive the maximum acceptance angle in an optical fiber. What is the fiber numerical aperture when $n_1 = 1.46$ and $n_2 = 1.44$? 8

   c) Draw the loss curve of an optical fiber for various wavelengths and explain the reasons of various peaks occurred. 10

5. a) Explain Snell's law (Law of refraction). 10

   b) A fiber with a core diameter $d = 9$ μm and N=0.11 is to be operated at a wavelength of 1.3 μm. How large is the V parameter of this fiber? 10

   c) To obtain single mode, discuss what one must do in relation to the V parameter and how to do that. 5

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6. a) Discuss the operation principle of a laser and a p-n photodiode. 10

b) Prove that the BER is minimum when the decision threshold is set close to a value given by $I_D = \frac{\sigma_0 I_1 + \sigma_1 I_0}{\sigma_0 + \sigma_1}$ 10

c) 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). 5

(i) Calculate the shot noise, thermal noise and relative intensity noise powers (in 1 Hz bandwidth).
(ii) Comment on the the dominating noise term in this photonic link.

7. a) Write various methods to fabricate optical fiber. Discuss Double crucible method for fiber fabrication. 10

b) Draw the energy band diagram for heterostructure p-n junction. 5

c) What are the advantages of p-n photodiode over p-i-n photodiode? 10

8. Discuss the following: 25
(i) MZM.
(ii) DFB laser.
(iii) Optical injection locking.
(iv) Optical heterodyning.

M.Sc. Engg./ Ph.D (EE) Date: 01 April, 2022

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

Semester Final Examination **Summer Semester: 2020 - 2021**
Course Number: EEE 6411 **Full Marks: 150**
Course Title: Wireless Ad Hoc and Sensor Networks **Time: 3.0 Hours**

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

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1. a) What do you understand by Ad-hoc networking? Why is such networking required when there are standard networks? What is self-organize characteristics in Ad-hoc networks? 7

   b) What is vehicular Ad-hoc networking (VANET)? 18
   Suppose there are two sink nodes located at Dhaka and Chittagong. Design a networks solution to exchange data between these two sink nodes with the help of vehicular Ad-hoc networking (VANET) and wireless connectivity enabled devices? Use suitable illustrations, diagrams and flowcharts.

   For your above design,
   i) Explain the architecture and functionality of your design.
   ii) Identify and solve the problems associated with your design.
   iii) Use and apply the techniques, skills and modern engineering tools of data flow mechanism in wireless data communication networking.

2. a) What is Delay Tolerant Networks (DTN)? What are the limitations associated with the Internet caused by current TCP/IP model? How does DTN overcome those problems. 7

   b) Design Delay Tolerant Networks (DTN) for the following scenarios (use suitable illustrations, diagrams and flowcharts): 18
   i) Inter-planetary communication.
   ii) Underwater communication.

   For your above designs,
   i) Explain the architecture and functionality of your design.
   ii) Identify and solve the problems associated with your design.
   iii) Use and apply the techniques, skills and modern engineering tools of data flow mechanism in wireless data communication networking.

3. a) What are the design goals and different design choices for Wireless LAN (WLAN)? How does a network designer define and differentiate among Wireless PAN (WPAN), Wireless LAN (WLAN), Wireless MAN (WMAN) and Wireless WAN (WWAN)? 10

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b) For data communication in the Internet using layering protocols, packet switching is more efficient than circuit switching. Define packet switching and circuit switching. For an effective packet switching, justify your design mechanism for the following issues when multiple data are transferring: 15

i) The mechanism for identifying each destination.
ii) Proper synchronization of each sender and corresponding destination.
iii) Suitable size and rate of the packet so that it can effectively control data loss, packet delay and throughput requirement.
iv) Proper mechanism to handle collision of packets and recognize beginning and ending of each packet.
v) Proper coordination among the shared network so that each network can ensure equal opportunity to transfer the data.

4. a) What is Wireless Sensor Networks (WSN)? 25
How do you use WSN to design networks in following scenarios (use suitable illustrations, diagrams and flowcharts):

i) Facility management,
ii) Machine surveillance and preventive maintenance,
iii) Precision agriculture,
iv) Medicine and health care,
v) Logistics,

For your above designs,

i) Explain the architecture and functionality of your design.
ii) Identify and solve the problems associated with your design.
iii) Use and apply the techniques, skills and modern engineering tools of data flow mechanism in wireless data communication networking.

5. a) As a wireless network designer, how do you consider the following performance metrics for the efficient wireless connectivity? 25
i) Throughput, ii) Delay, iii) Fairness, iv) Stability, v) Channel fading, vi) Energy consumption, and vii) Power management.

Justify your answer by briefly explaining each of them.

6. a) You and your friend want to share data between two wireless enable devices with the help of Bluetooth. 25

What are the basic characteristics and parameters of Bluetooth communication?

At the beginning of the data transferring, how does your Bluetooth device create connection with your friend's device?

How does Bluetooth operate during data transferring?

Define Piconets and briefly discuss Bluetooth Piconets. What is the difference between IR and Bluetooth?

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M. Sc. /Ph.D. in EEE

April 05,2022

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — **Summer Semester : 2020 - 2021**

Course Number: EEE 6703 — **Full Marks: 150**

Course Title: Modern Control System — **Time : 3 Hours**

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

1.a) What is the downside of the determining controllability and observability by inspection? [5]

b) 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. [10]

c) Determine whether the system is controllable. [10]

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

2.a) What is the challenge in designing controller for the system not represented in phase variable form? [5]

b) Design a linear state-feedback controller to yield 20% overshoot and a settling time of 2 seconds for a plant that is represented in state space in cascade form by [20]

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

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

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

3.a) Explain with necessary diagram and formula different configuration of observer design for systems represented in observer canonical form. [10]

b) Design an observer for the plant whose estimated plant is represented in state space in observer canonical form as the observer will respond 10 times faster than the controlled loop design. [15]

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

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

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

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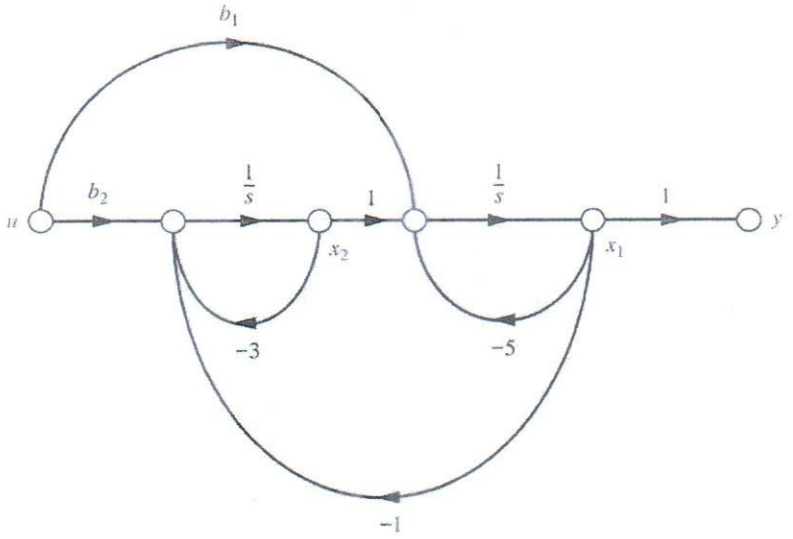
4.a) i. Given the plant shown in the following, what relationship exists between b1 and b2 to make the system uncontrollable? [15]
ii. What values of b2 will make the system uncontrollable if b1 = 1?



b) Determine whether the system is observable. [10]

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

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

5.a) Derive necessary formulas related to alternative approaches to observer design. [10]

b) Design an observer for the plant [15]

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

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

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

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

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

6.a) Derive necessary formula in steady-state error design via integral control with suitable diagram. [12]

b) Design an integral controller for the plant [13]

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

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

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