B.Sc. Engg. (EE), 1st Semester 108 Date : May 15, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A.Y. 2018-2019
Course No.: EEE 4101 — Time: 3 Hours
Course Title: Electrical Circuit I — Full Marks: 150

There are **8 (eight)** questions. Answer **any 6 (six)** questions. All questions carry equal marks. Marks for parts of the questions 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) The current through and voltage across an element vary with time as shown in Figure 1(a). Find: 9+4
   i) the expression of power delivered to the element for $0 < t < 25$ and
   ii) the total energy delivered to the element between $t = 0$ and $t = 25$ s.
   The element voltage and current adhere to the passive convention.

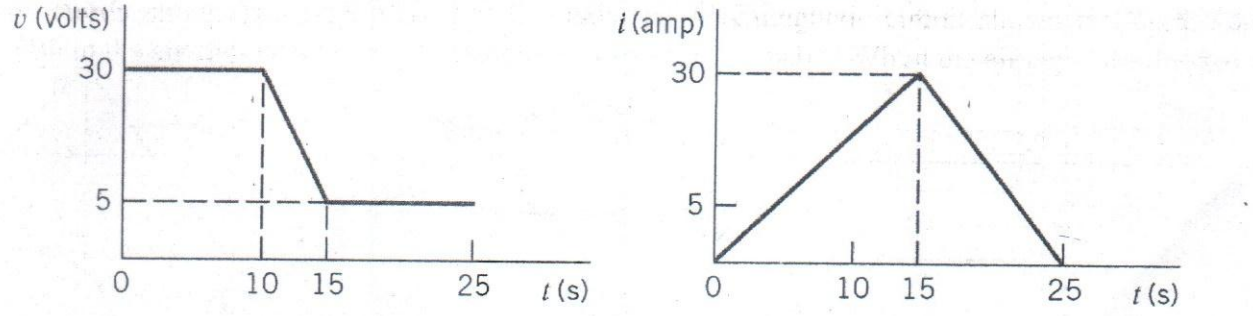


Figure 1(a)

b) Find the power absorbed/supplied by the dependent source shown in Figure 1(b) if $V_o = 12$ V. 12

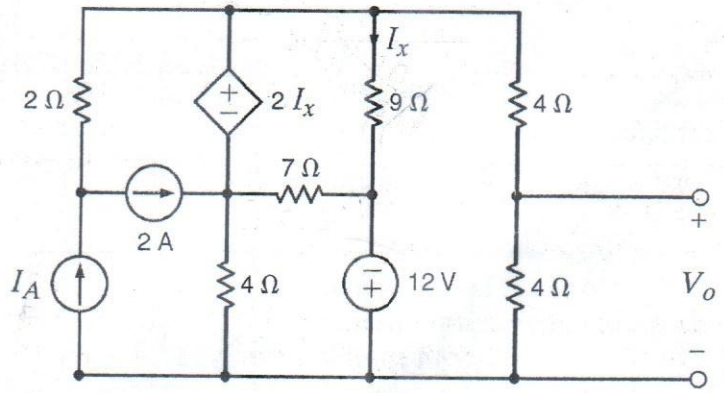


Figure 1(b)

2. a) Use nodal analysis to determine the node voltages defined in the circuit in Figure 2(a). 13

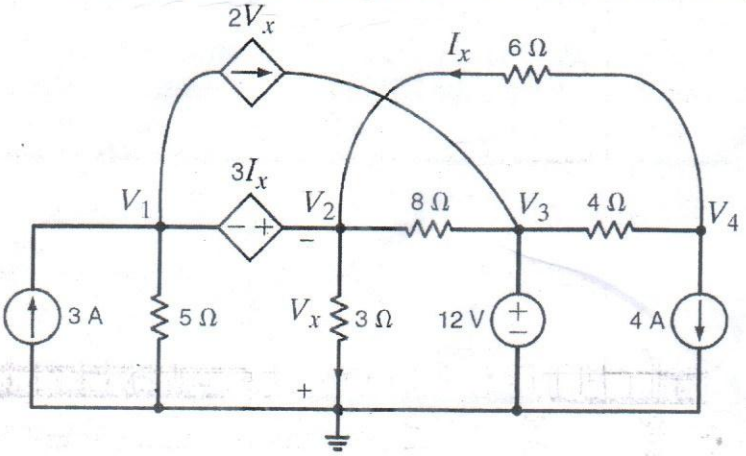


Figure 2(a)

b) Find V_o in the network in Figure 2(b) using mesh current analysis. 12

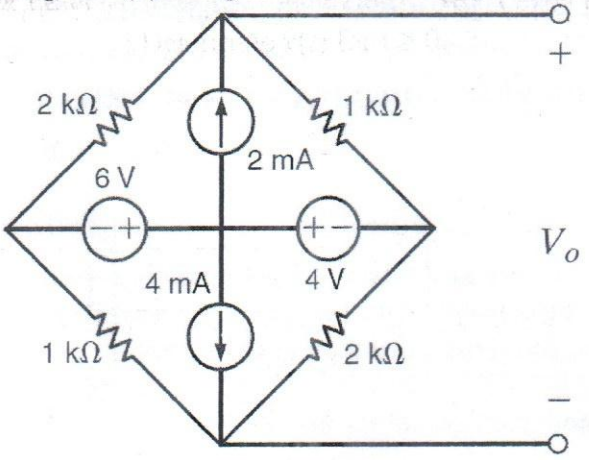


Figure 2(b)

3. a) Find V_o in the circuit of Figure 3(a) using superposition. 13

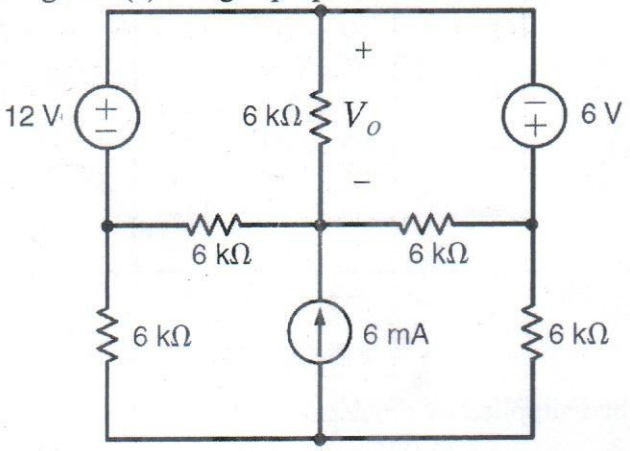


Figure 3(a)

b) Find the Thévenin's equivalent of the circuit shown in Figure 3(b) and determine V_o using Thévenin's equivalent circuit. 12

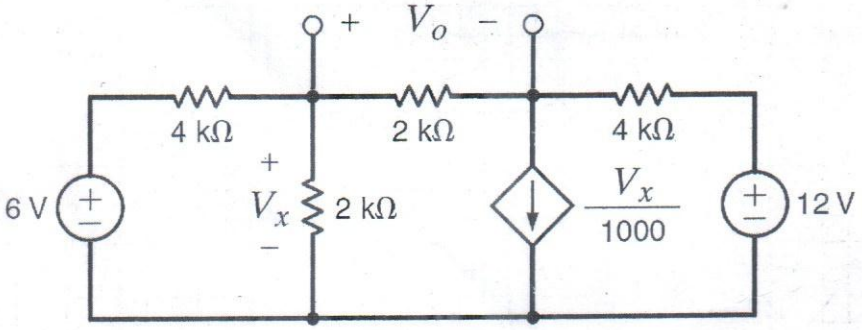


Figure 3(b)

4. a) Find the power dissipated in the 3 Ω resistor of the circuit shown in Figure 4(a). Also, find the energy stored in the 2 F capacitor and the 2 H inductor of the same circuit. 7

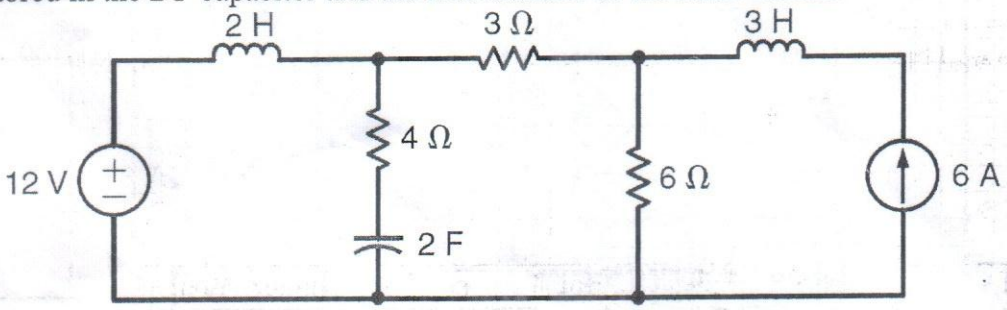


Figure 4(a)

b) The inductor current in the circuit shown in Figure 4(b) is given by $i(t) = 5 - 3e^{-4t}$ A for $t \geq 0$. 6

Determine $v(t)$ for $t \geq 0$.

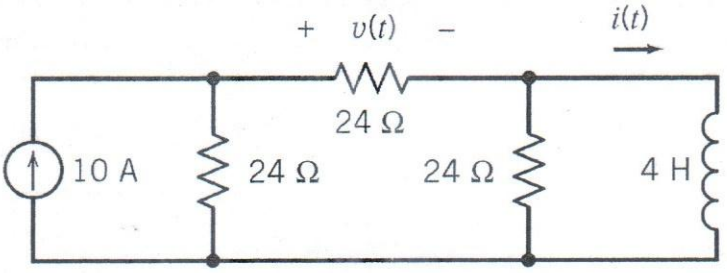


Figure 4(b)

c) Derive the general equations of energy stored in a capacitor and an inductor. 6+6

5. a) Find the average value, rms value and peak factor of the voltage waveform shown in Figure 5(a). 4+6 +3

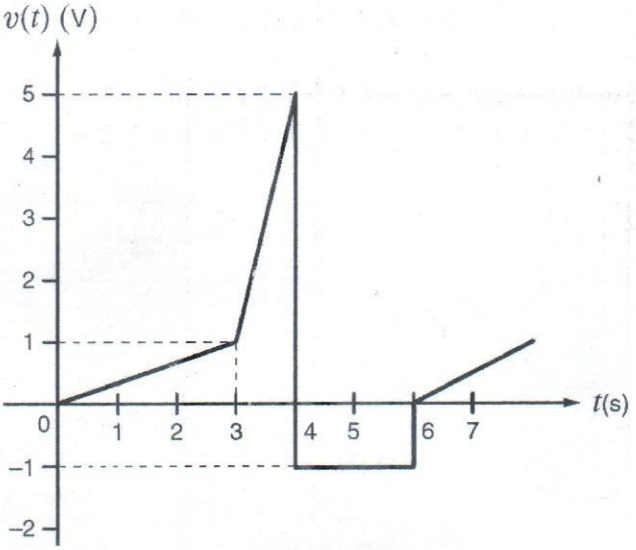


Figure 5(a)

b) Using phasors, find: 6×2

i) $40\sin 50t + 30\cos(50t - 45°)$ and

ii) $20\sin 400t + 10\cos(400t + 60°) - 5\sin(400t - 20°)$.

6. a) Calculate the value of Z_{ab} of the network shown in Figure 6(a). 13

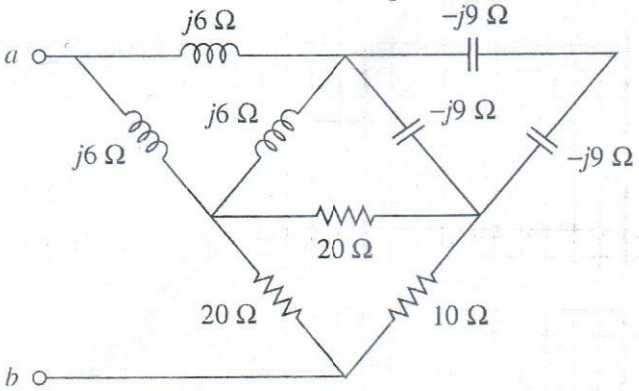


Figure 6(a)

b) Find the currents I_0, I_1 and I_2 in the circuit shown in Figure 6(b). Also, draw the currents and source voltage in the same phasor diagram. 12

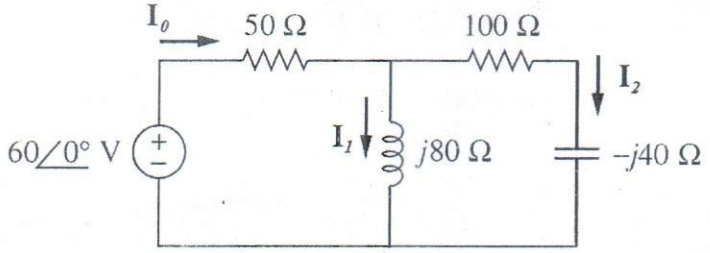
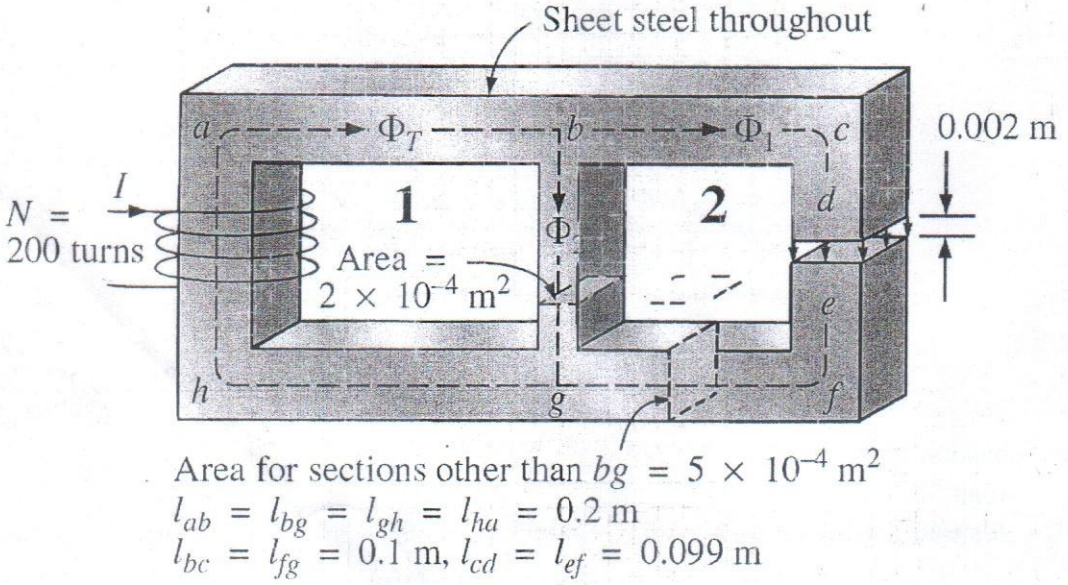


Figure 6(b)

7. a) An industrial load operates at 30 kW, 0.8 pf lagging. The load voltage is $240\angle 0°$. The real and reactive power losses in the transmission-line feeder are 1.8 kW and +2.4 kVAR, respectively. Find the impedance of the transmission line and the input voltage to the line. 13

b) Mathematically derive the condition for maximum power transfer in an AC circuit where source voltage is $\mathbf{V}_{Th}$, line impedance is $\mathbf{Z}_{Th} = R_{Th} + jX_{Th}$ and load impedance is $\mathbf{Z}_L = R_L + jX_L$. 12

8. a) For the series-parallel magnetic circuit shown in Figure 8(a), find the value of I required to establish a flux of $\Phi_g = 2\times10^{-4}$ Wb in the air gap. Use the two B-H curves supplied at the end. 13



Area for sections other than bg = 5×10^{-4} m^2

$l_{ab} = l_{bg} = l_{gh} = l_{ha} = 0.2$ m

$l_{bc} = l_{fg} = 0.1$ m, $l_{cd} = l_{ef} = 0.099$ m

Figure 8(a)

b) Show the mesh currents' directions and write the KVL equations for the meshes in the circuit shown in Figure 8(b). 12

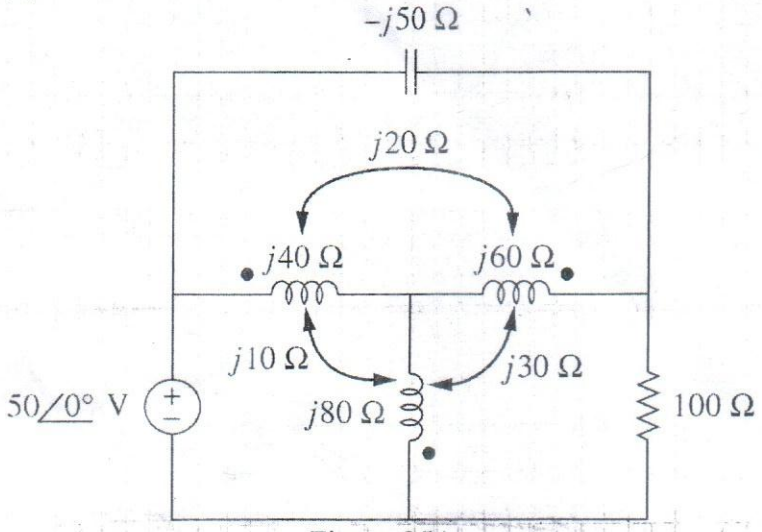
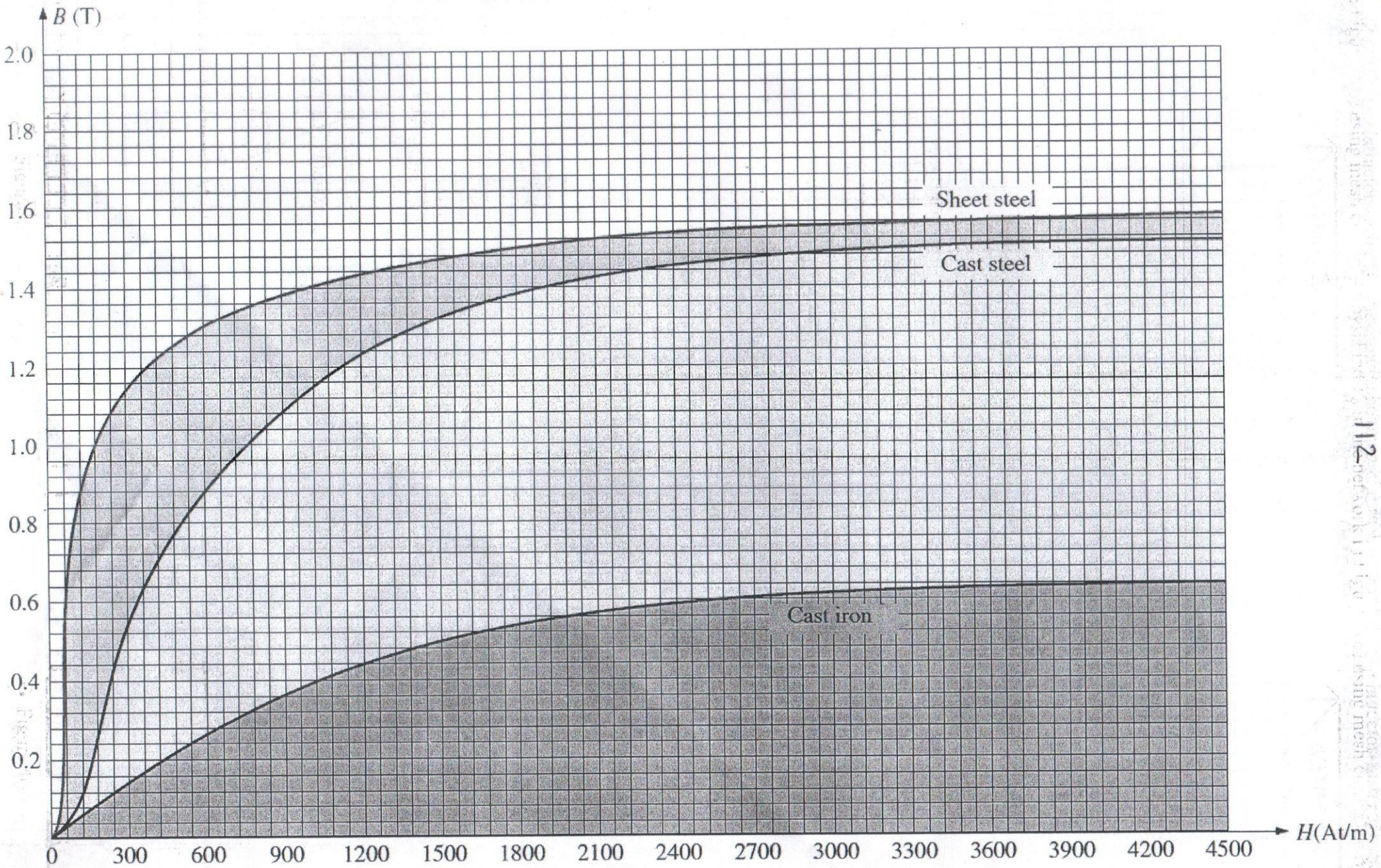
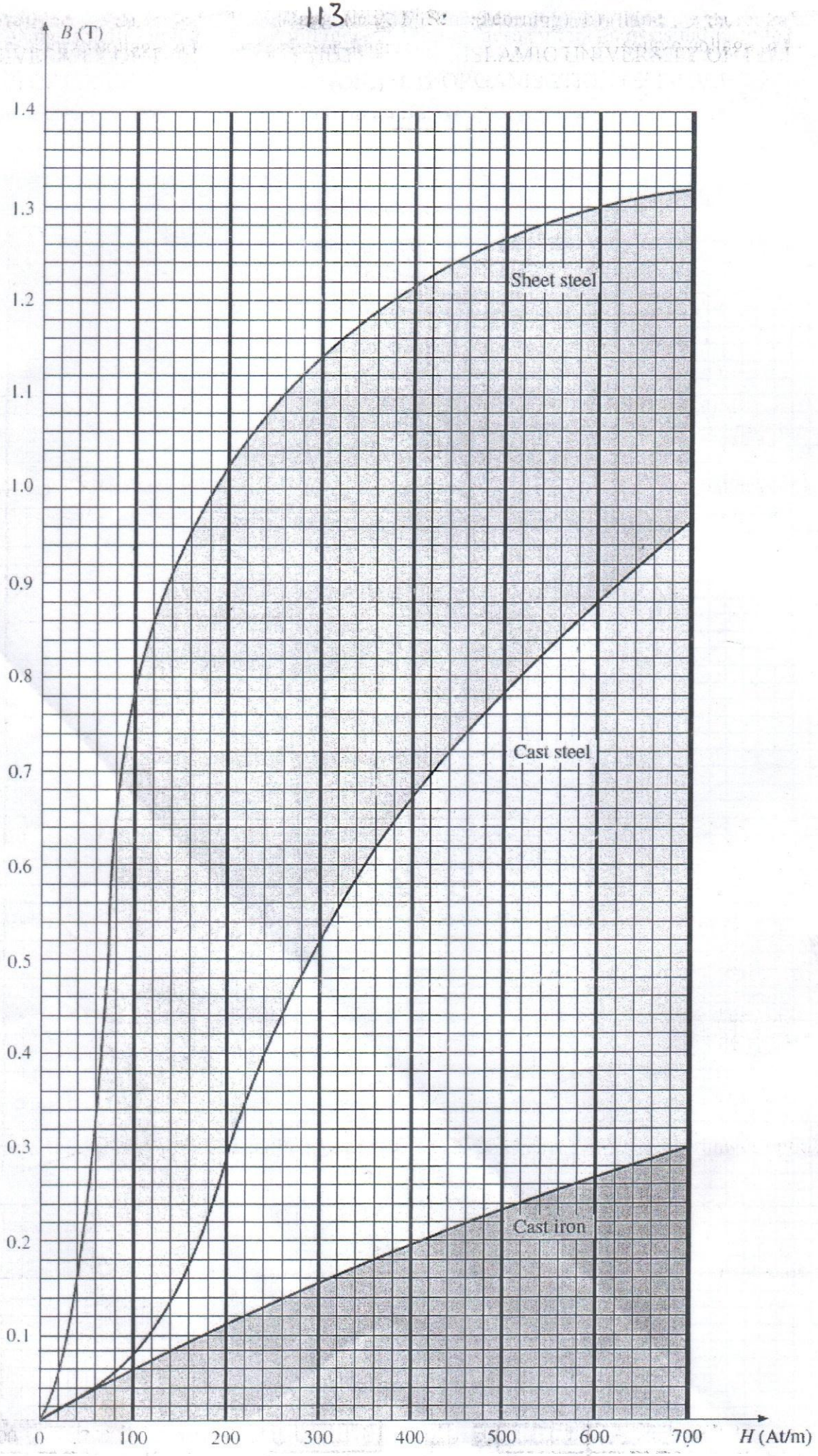


Figure 8(b)



B-H curve 1 for Q. 8(a)



B-H curve 2 for Q. 8(a)

B. Sc. Engg. (EE), 1st Sem. Date: 28 May, 2019 (Morning)

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

Semester Final Examination
Course No.: Phy 4121
Course Title: Engineering Physics I

Winter Semester A. Y. 2018-2019
Time: 3 Hours
Full Marks: 150

There are **8 (eight)** questions. Answer **any 6 (six)** questions taking at least three from each section. All questions carry equal marks. Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper.

Section A

1. (a) Briefly explain classification of magnetic materials. Draw **M** versus **H** plots for all types of magnetic materials and briefly explain these behaviors. 10
   (b) Define magnetic moment. Explain the origin of magnetic moment at the atomic level and hence derive an expression for the magnetic moment of the electron in the first Bohr orbit. 10
   (c) Distinguish between soft and hard ferromagnetic materials. 5

2. (a) Briefly explain the following terms of superconductivity: (i) critical temperature, (ii) critical magnetic field and (iii) critical current. 9
   (b) Describe the differences between Type-I and Type-II superconductors. 7
   (c) Briefly explain some of the applications of superconductors. 9

3. (a) Distinguish among metal, insulator and semiconductor? Mention the classification of semiconductors. 6
   (b) Derive expressions for conductivity of intrinsic and extrinsic semiconductors. Explain the effect of temperature on the conductivity of semiconductors. 15
   (c) Draw the band diagrams of p-type and n-type semiconductors. 4

4. (a) Why does the interatomic or intermolecular bond exist in solid? Briefly explain various types of bonds in solids. 10
   (b) Draw a typical unit cell of sodium chloride crystal. What is cohesive energy? Derive an expression for the cohesive energy of sodium chloride crystal. 15

Section B

5. (a) Distinguish between single slit and double slit diffraction patterns. 7

(b) Explain dispersive power of a diffraction grating. Show that the dispersive power is proportional to the number of lines per cm of the grating surface. 13

(c) Deduce the missing orders for a double slit Fraunhofer diffraction pattern, if the slit widths are 0.16 mm and they are 0.8 mm apart. 5

6. (a) What is polarization of light? Why sound waves cannot be polarized? 7

(b) What is angle of polarization? State Brewster's law for polarization of light. Show that the reflected and refracted rays are at right angles to each other. 13

(c) Explain how light can be polarized by reflection? 5

7. (a) Explain double refraction in a calcite crystal. 7

(b) Write down the working principle of a Nicol prism. How can a Nicol prism be used as a polarizer as well as an analyzer of light? 13

(c) What is specific rotation? Determine the specific rotation of the given sample of sugar solution if the plane of polarization is turned through 13.2^0. The length of the tube containing 10 % sugar solution is 20 cm. 5

8. (a) How does the output current of a photoelectric cell depend on the frequency and intensity of light? 7

(b) Explain the construction and operation of a photo emissive cell. 13

(c) When a monochromatic point source of light is at a distance 0.2 m from a photoelectric cell, the stopping potential and the saturation photocurrent are 0.6 V and 18 mA, respectively. If the same source is placed 0.6 m away from the photocell, what will be the new stopping potential and saturation photocurrent? 5

B.Sc. Engg. (EE)/ HDEE, 1st Sem. Date: May 23, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: Math 4121
Course Title: Mathematics I

Winter Semester, A.Y. 2018-2019
Time: 3 hours
Full Marks: 150

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

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1. a) If $y = a\cos(\ln x) + b\sin(\ln x)$ then, show that $x^2 y_{n+2} + (2n+1)xy_{n+1} + (n^2+1)y_n = 0$. 10

   b) Evaluate $\underset{x\to 0}{Lt}\ (\cot^2 x)^{\sin x}$. 07

   c) Verify Euler's theorem for the function, $u = x^5 + y^5 + 3x^4 y + 3xy^4$ 08

2. a) A window in the form of a rectangle is surmounted by a semicircle. If the total perimeter is 25 ft, find the dimensions of the window so that the greatest possible amount of light may be admitted. 13

   b) Show that $\sec x + \ln\cos^2 x$ is a maximum for $x = 0$ and a minimum for $x = \pi/3$. Also find the maximum and minimum values of the function. 12

3. a) If $lx+my=1$ touches the curve $(ax)^n + (by)^n = 1$ show that $(l/a)^{\frac{n}{n-1}} + (m/b)^{\frac{n}{n-1}} = 1$. 13

   b) Find the centre of curvature of the curve, $y = x^3 + 2x^2 + x + 1$ at (1, 5) and hence find the circle of curvature. 12

4. Integrate the following: 09+08 +08

   (i) $\int \frac{\cos x dx}{\sqrt{(5\cos^2 x - 12\sin x + 4)}}$ (ii) $\int e^x \frac{x^2+1}{(x+1)^2} dx$ (iii) $\int \frac{dx}{(1+x)\sqrt{1+x-x^2}}$

5. a) Integrate the following: 08+08

   (i) $\int \frac{x^2 dx}{(x-1)(x-2)(x-3)}$ (ii) $\int \frac{3\sin x + 14\cos x + 6}{4\sin x + 5\cos x + 3} dx$

   b) Find the reduction formula for $I_{m,n} = \int x^m (\ln x)^n dx$ 09

6. a) Evaluate the integral $\int_0^{\frac{1}{2}\pi} \frac{xdx}{\sec x + \operatorname{cosec} x}$ 13

b) Evaluate $\underset{n\to\infty}{Lt}\left[\left(1+\frac{1^2}{n^2}\right)\left(1+\frac{2^2}{n^2}\right)\left(1+\frac{3^2}{n^2}\right).....\left(1+\frac{n^2}{n^2}\right)\right]^{\frac{1}{n}}$ 12

7. a) Show that $\int_a^b (x-a)^m (b-x)^n dx = (b-a)^{m+n-1} \frac{\Gamma(m+1)\Gamma(n+1)}{\Gamma(m+n+2)}$. 08

b) Evaluate $\int_1^2 \sqrt{x-\frac{1}{x}}\, dx$ by Simpson's rule taking 8 subintervals. 08

c) Find the length of the arc of the parabola $y^2 = 4ax$ which is intercepted between the points of intersection of the parabola and the straight line $3y = 8x$. 09

8. a) Find the area of the portion of the circle $x^2 + y^2 = 1$ which lies inside the parabola $y^2 = 1 - x$. 10

b) The arc of the asteroid, $x = a\cos^3\theta$, $y = a\sin^3\theta$ from $\theta = 0$ to $\theta = \pi/2$ revolves about the x-axis. Find the volume and surface area of the solid generated. 15

B.Sc. Engg. (EE), 1st Sem. Date: May 20, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A.Y. 2018-2019
Course No.: Math 4123 — Time: 3 Hours
Course Title: Mathematics II (Matrices and Differential Equations) — Full Marks: 150

There are **8 (eight)** questions. Answer **any 6 (six)** questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The symbols have their usual meanings.

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1. a) Reduce the quadratic form $q = x_1^2 + 3x_2^2 - 2x_3^2 + 2x_1x_2 + 4x_1x_3$ to the canonical form and find rank, index and signature of the form. 13

   b) State Cayley-Hamilton theorem and verify for the matrix 12

$$A = \begin{bmatrix} 1 & -1 & 1 \\ 1 & 2 & 1 \\ 1 & 0 & 3 \end{bmatrix}$$ and hence find A^4.

2. a) Define characteristic equation of a matrix. Find the characteristic equation of the matrix 7

$$\begin{bmatrix} 1 & 3 & 4 \\ 3 & 5 & 6 \\ 4 & 6 & 7 \end{bmatrix}$$

   b) The system of linear differential equations for the currents $i_1(t)$ and $i_2(t)$ in a electrical networks is 18

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

$$L_1 \frac{di_2}{dt} = R_2 i_1 - R_2 i_2$$

   Use matrix method to solve the system if R_1= 16 ohms, R_2= 6 ohms L_1 = 2 henry, L_2 =2 henry and E = 60 volt, $i_1(0) = i_2(0) = 0$.

3. a) Determine whether the functions e^x, e^{-x}, *and* e^{2x} are dependent or not. 6

   b) Find a differential operator that annihilates the function $f(x) = 4x - 5 + 6xe^{2x}$ and hence solve the differential equation $y'' - 2y' - 3y = f(x)$ by the method of undetermined coefficients. 19

4. a) An RLC circuit connected in series has R=180 ohms, *C=1/280* farad, L = 20 henries, and applied voltage *E(t)=10 cos t* . Assuming no initial charge on the capacitor, but an initial current of 1 ampere at t = 0 when the voltage is first applied. Derive the differential equation and hence find the charge on the capacitor. 13

b) Solve the differential $\left[xD^2+(1-x)D-1\right]y=e^x$ by factorization operator. 12

5. a) Change the following differential equation to constant coefficient and hence solve: 16

$$x^2y''+xy'+y=\ln x.$$

b) Solve the differential $x^2y''-2xy'+2y=x^4e^x$ by variation of parameters. 15

6. a) Solve: 13

$$X'=\begin{pmatrix}2&1&6\\0&2&5\\0&0&2\end{pmatrix}X$$

b) Solve the system: 12

$$X'=\begin{pmatrix}-3&1\\2&-4\end{pmatrix}X+\begin{pmatrix}3t\\e^{-t}\end{pmatrix}$$

7. Solve the differential equation in series $2x(1-x)y_2+(1-x)y_1+3y=0$ by the method of Fröbenius. 25

8. Find the steady temperature distribution in a thin plate bounded by the lines $x=0, x=a, y=0, and\ y=\infty$ assuming that heat cannot escape from either surface; the sides $x=0, x=a$, are kept at temperature zero. The lower edge $y=0$ is kept at temperature f(x) and the upper edge is kept $y=\infty$ at temperature zero. 25

Library 120

B.Sc. SWE, 1st Sem. Date: May 28, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

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

Winter Semester, A.Y. 2018-2019
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. Symbols carry their usual meanings.

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1. a) For the circuit shown in Fig. 1(a), find out the values of v_0 and i_0. 8

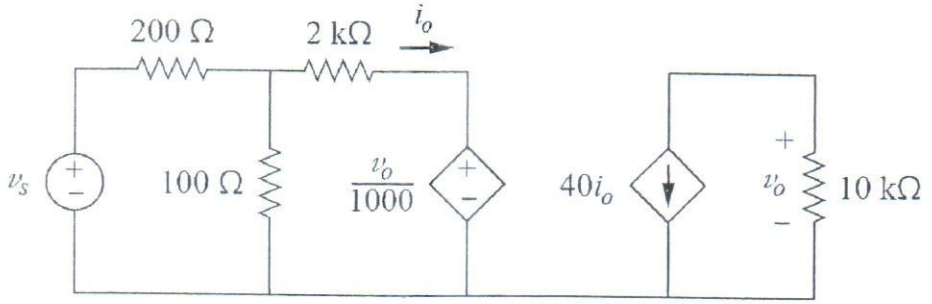

Fig. 1(a)

b) Find current, I in the circuit of Fig. 1(b). Assume, all resistors are of equal valued (assume any value) and E = 20 V. 8

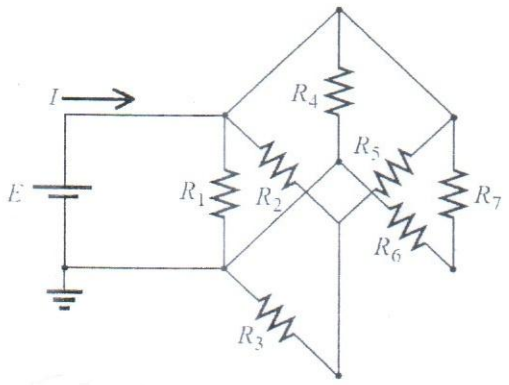

Fig. 1(b)

c) Calculate i_1, i_2 and i_3 as indicated in the circuit of Fig. 1(c). 9

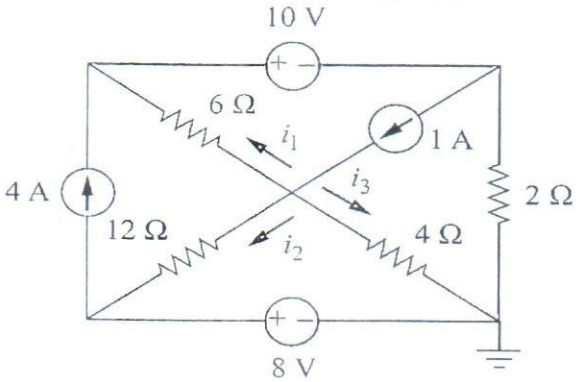

Fig. 1(c)

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2. a) Find current, i_s in the circuit of Fig. 2 (a), if the voltage v_0 across the 2 Ω resistor is 10 cos 2t V and draw the qualitative phasor diagram. 15

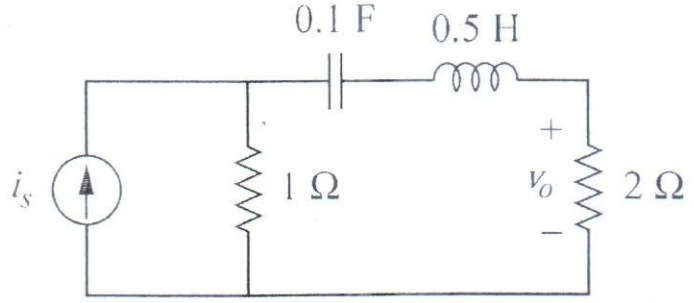

Fig. 2 (a)

b) Find I in the circuit of Fig. 2 (b). 10

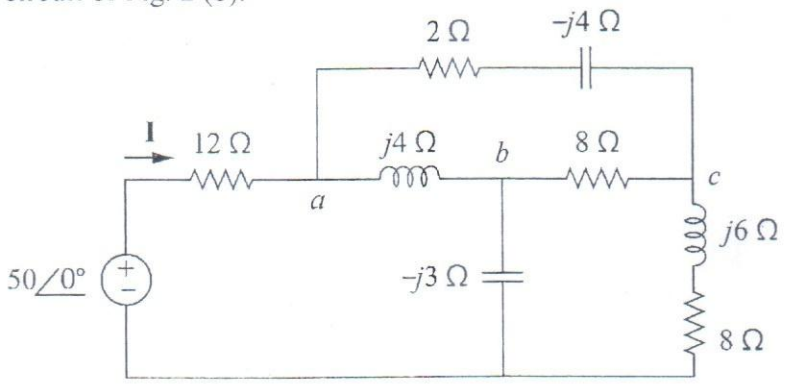

Fig. 2 (b)

3. a) Find v_1 and v_2 in the circuit of Fig. 3 (a) using Nodal Analysis. 12

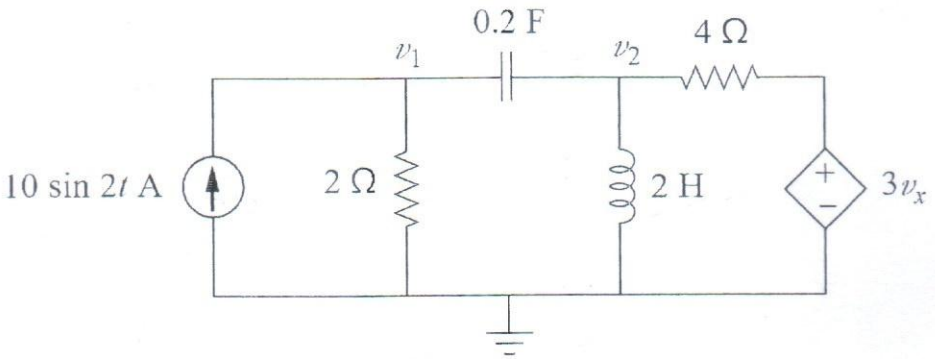

Fig. 3 (a)

b) Determine the Thevenin equivalent of the circuit shown in Fig. 3 (b) as seen from terminals a-b. 13

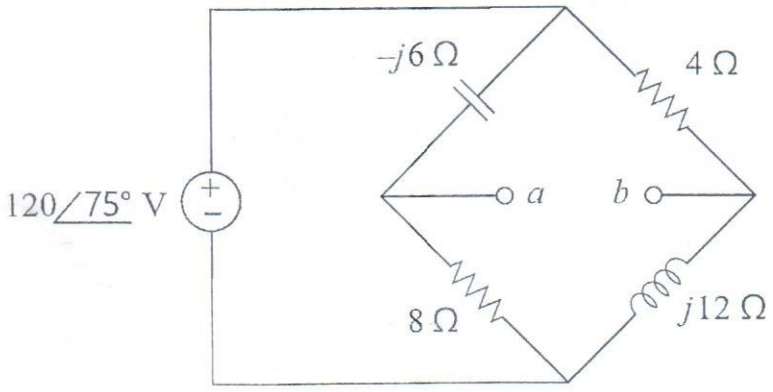

Fig. 3 (b)

4. a) Determine the rms value of the full-wave rectified sine wave shown in the Fig. 4 (a). If the voltage is applied to a 6 Ω resistor, find the average power dissipated in it. 10

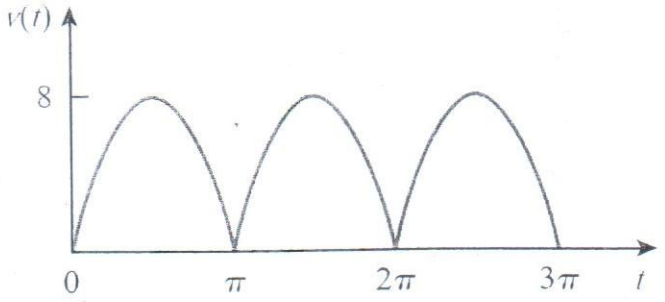

Fig. 4 (a)

b) Find v_o of the network in Fig. 4 (b) using superposition theorem. 15

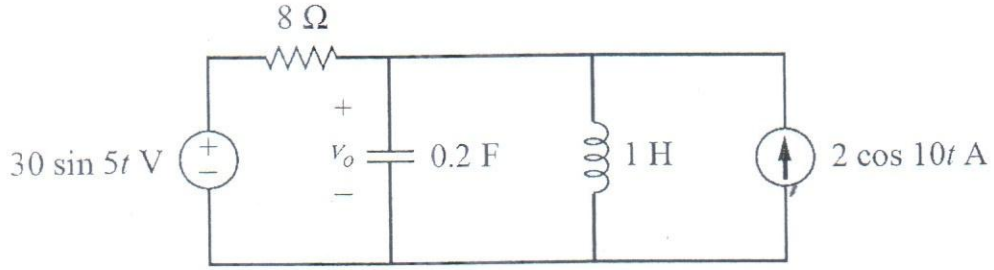

Fig. 4 (b)

5. a) What are the conditions for getting maximum average power transferred at the load using an AC circuit? Derive them for a series AC circuit. 10

b) Find V_0 in the circuit of Fig. 5 (b) using Mesh Analysis. 15

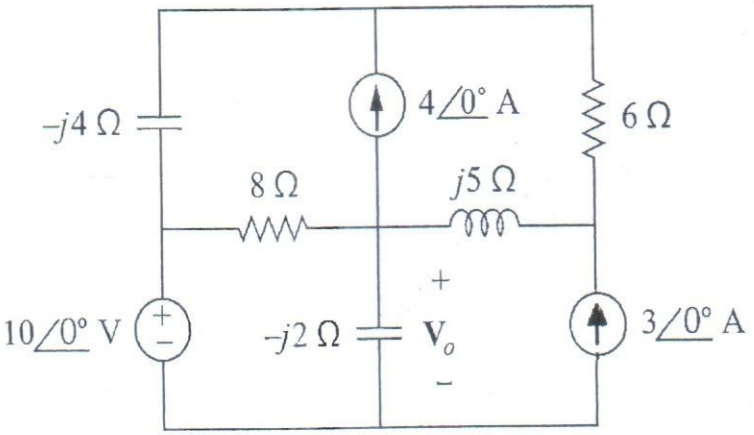

Fig. 5 (b)

6. a) In Fig. 6 (a), the resistor R_L is adjusted until it absorbs the maximum average power. Calculate R_L and the maximum average power absorbed by it. 9

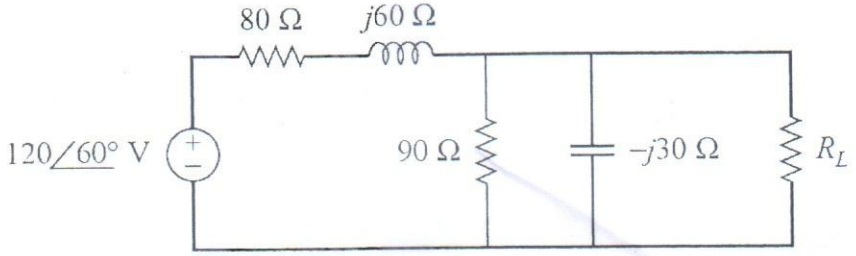

Fig. 6 (a)

b) Show that a resistive load (R) absorbs average power at all times, while a reactive load (L or C) absorbs zero average power. 8

c) When connected to a 220-V (rms), 50-Hz power line, a load absorbs 4 kW at a lagging power factor of 0.8. Find the value of capacitance necessary to raise the pf to 0.95. 8

7. a) Mention the advantages of three-phase system comapred to single-phase system in terms of power loss. Justify your answers with necessary diagrams and equations. 10

b) Two balanced loads are connected to a 240 kV, 50-Hz line as shown in Fig. 7 (b) below. Load 1 draws 30 kW at a power factor of 0.6 lagging, while load 2 draws 45 kVAR at a power factor of 0.8 lagging. Assuming the a-b-c sequence, determine the line currents, i_{a1}, i_{a2}, i_a, i_b and i_c as indicated in Fig. 7 (b). 15

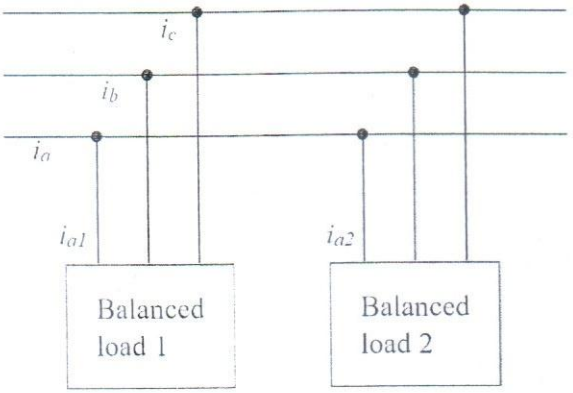

Fig. 7 (b)

8. a) For a balanced delta-wye system, determine the expressions for all the phase voltages, line voltages, phase currents and line currents for the b-a-c sequence along with phasor diagrams. 12

b) Find the line currents in the following unbalanced three-phase circuit shown in Fig. 8 (b) and draw the qualitative phasor diagram showing phase voltages and line currents flowing through the load. 13

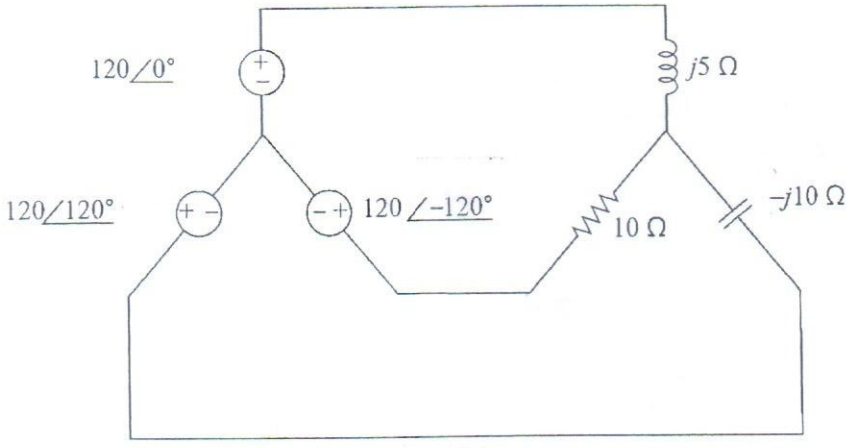

Fig. 8 (b)

BBA in TM, 1st Sem. Library 124 Date: May 16, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2018
Course No.: EEE 4161 — Time: 3 Hours
Course Title: Electrical and Electronic Technology I — 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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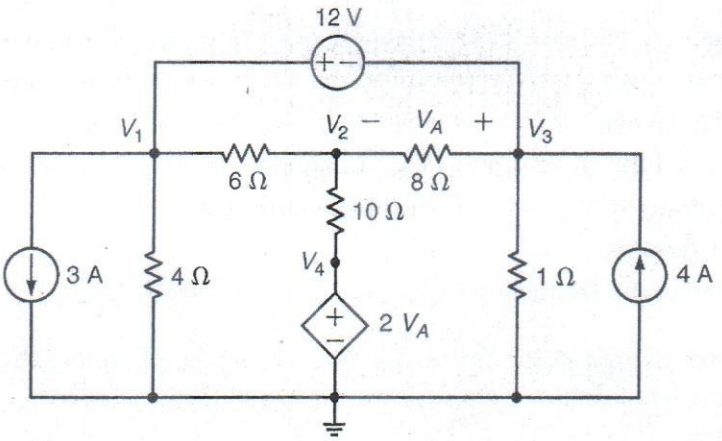
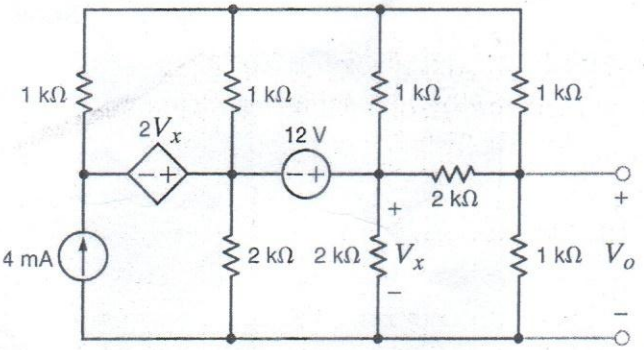
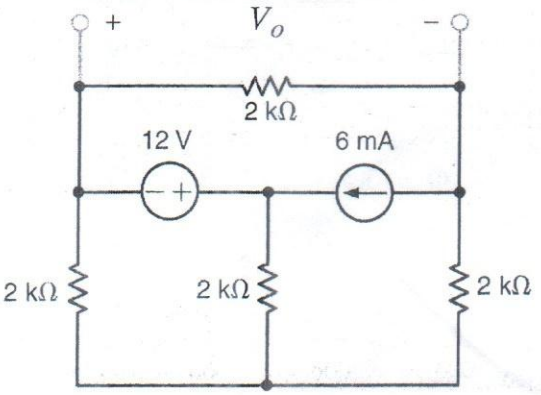
1. a) Use nodal analysis to find V_1, V_2, V_3 and V_4 in the following figure. 12



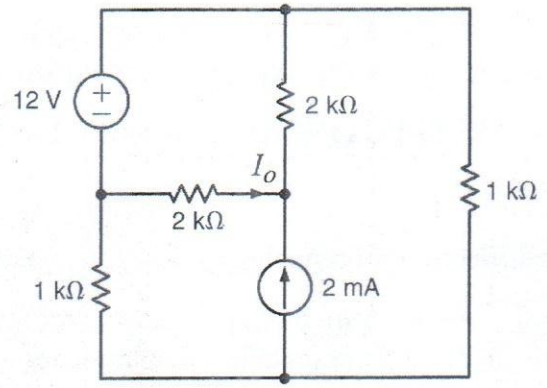
b) Use loop analysis to find Vo for the circuit in figure below. 13



2. a) Find V_0 for the circuit in figure below using superposition theorem. 12



b) Find I_0 for the circuit in figure below using Thevenin's theorem. 13



3. a) Find the equation for power and energy in L branch and draw the voltage, current and power in the same plot. 08

b) A voltage $v = 150 \cos 314t$ volts is applied to a purely resistive branch of $R = 30$ ohms. 08

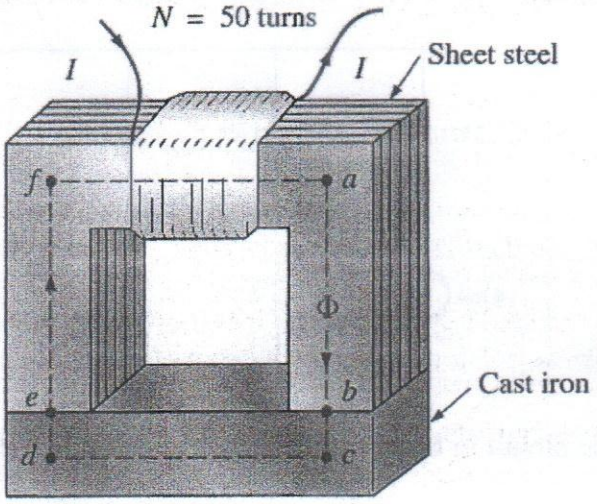
i) Write down the expression for i as a function of time, employing numerical coefficients.

ii) What is the frequency of the voltage and current variations?

iii) Write down the expression for power p as a function of time, employing numerical coefficients.

iv) What is the frequency of the power variation?

c) The electromagnet in the following figure has picked up a section of cast iron. Determine the current I required to establish the indicated flux in the core. 09



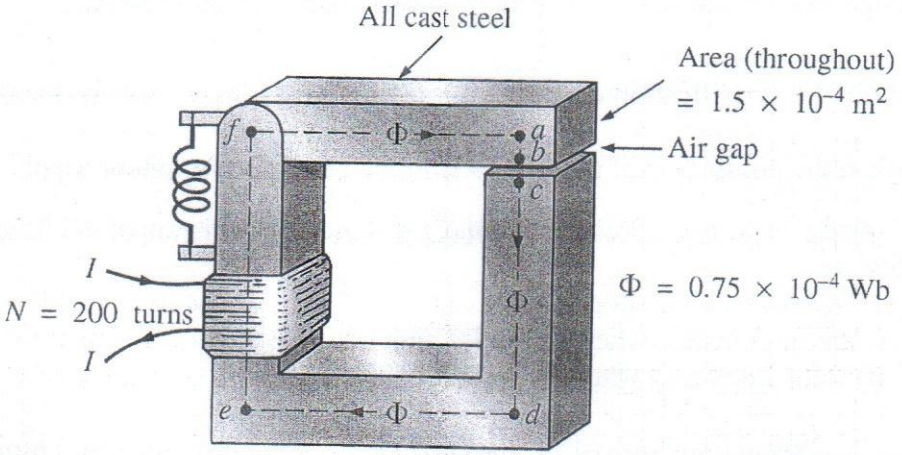
$l_{ab} = l_{cd} = l_{ef} = l_{fa} = 4$ in.

$l_{bc} = l_{de} = 0.5$ in.

Area (throughout) = 1 in.^{2}

$\Phi = 3.5 \times 10^{-4}$ Wb

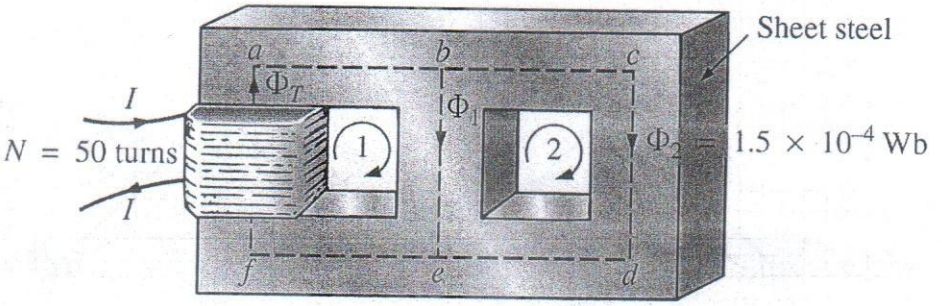
4. a) Find the value of I required to establish a magnetic flux of $\varphi = 0.75 \times 10^{-4}$ Wb in the series magnetic circuit in the following figure. 12



$l_{cdefab} = 100 \times 10^{-3}$ m

$l_{bc} = 2 \times 10^{-3}$ m

b) Determine the current I required to establish a flux of 1.5×10^{-4} Wb in the section of the core indicated in the following figure. 13



$l_{bcde} = l_{efab} = 0.2$ m

$l_{be} = 0.05$ m

Cross-sectional area $= 6 \times 10^{-4}$ m² throughout

5. a) Considering voltage $v = V_m \sin\omega t$ volts, derive the current, impedance and power expression for an RL branch. Draw the voltage, current and power in the same plot. 12

b) R = 10 Ω and L = 0.05 H are connected in series and energized by a 25-cycle sinusoidal voltage, the maximum value of which is 150 volts. 13

i) Find the complete impedance expression for the RL branch.

ii) Write down the expression for the supply voltage as a function of time, making v = 75 (dv/dt positive) at t = 0.

iii) Write down the expression for current as a function of time, assuming that the voltage in (ii) is applied to the branch. Employ numerical coefficients.

iv) Write down the expression for the instantaneous power delivered to the branch as a function of time. Express the result in three terms: a number, one cosine, and one sine term. What is the average power delivered?

6. a) Explain different types of generators. 07

b) What is the voltage equation of a motor? Find the condition for maximum power transfer. 08

c) A 4-pole, lap-wound, dc shunt generator has a useful flux per pole of 0.07 Wb. The armature winding consists of 220 turns each of 0.004 Ω resistance. Calculate the terminal voltage when running at 900 r.p.m. if the armature current is 50 A. 10

7. a) Explain the classification of AC motor in terms of their principle of operation. 08

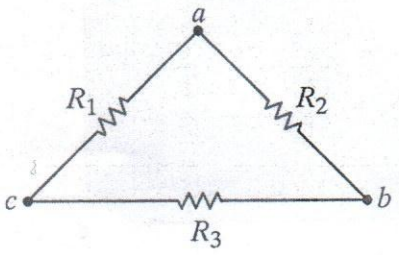
b) Explain the production of rotating field in the case of a two-phase supply induction motor. 10

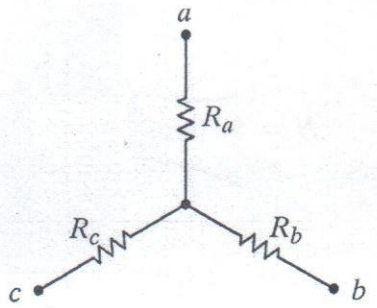
c) A 3-phase induction motor is wound for 4 poles and is supplied from 50 Hz system. Calculate 07
   i) the synchronous speed,
   ii) the rotor speed, when slip is 4% and
   iii) rotor frequency when rotor runs at 600 rpm.

8. a) What is voltage transformation ratio? A 25-kVA transformer has 500 turns on the primary and 50 turns on the secondary winding. The primary is connected to 3000 V, 50 Hz supply. Find the full load primary and secondary currents, secondary e.m.f. and the maximum flux in the core. Neglect leakage drop and no-load primary current. 08

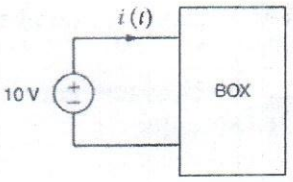
b) Derive the equations for R_1, R_2 and R_3 in terms of R_a, R_b and R_c and vice versa from the following figure. 09

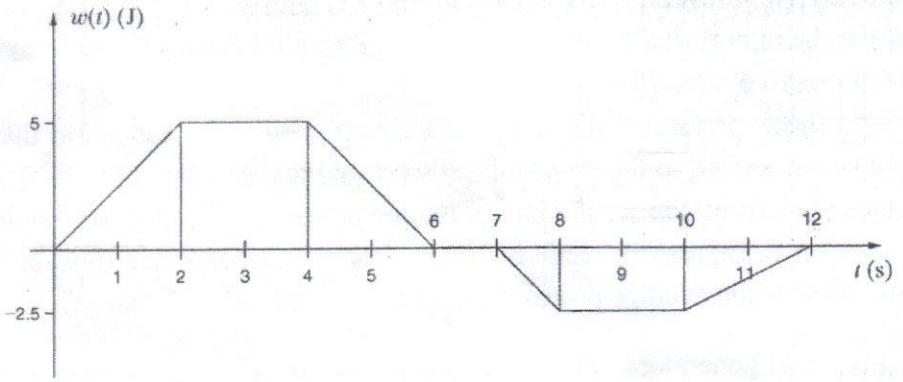
i)

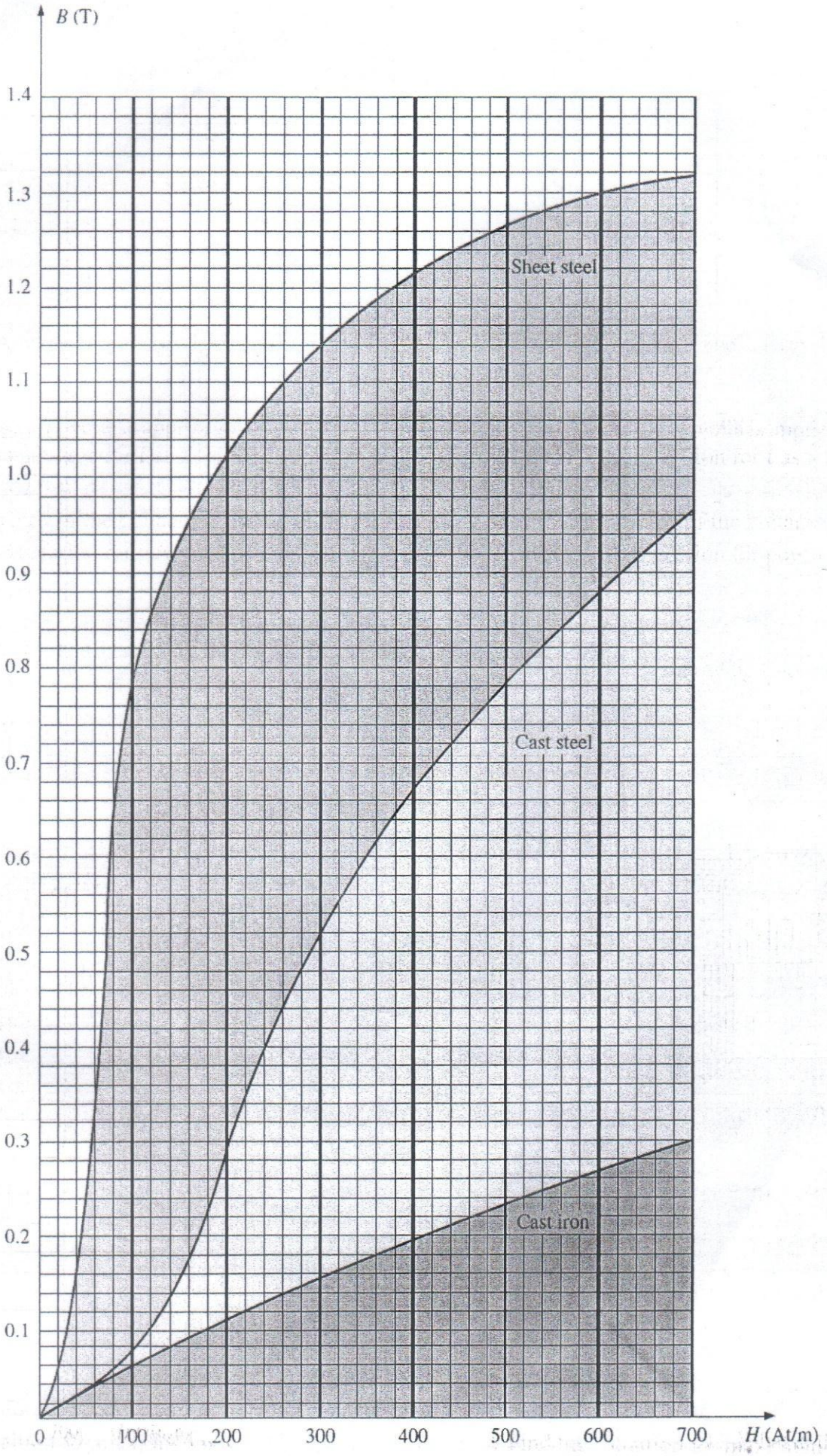


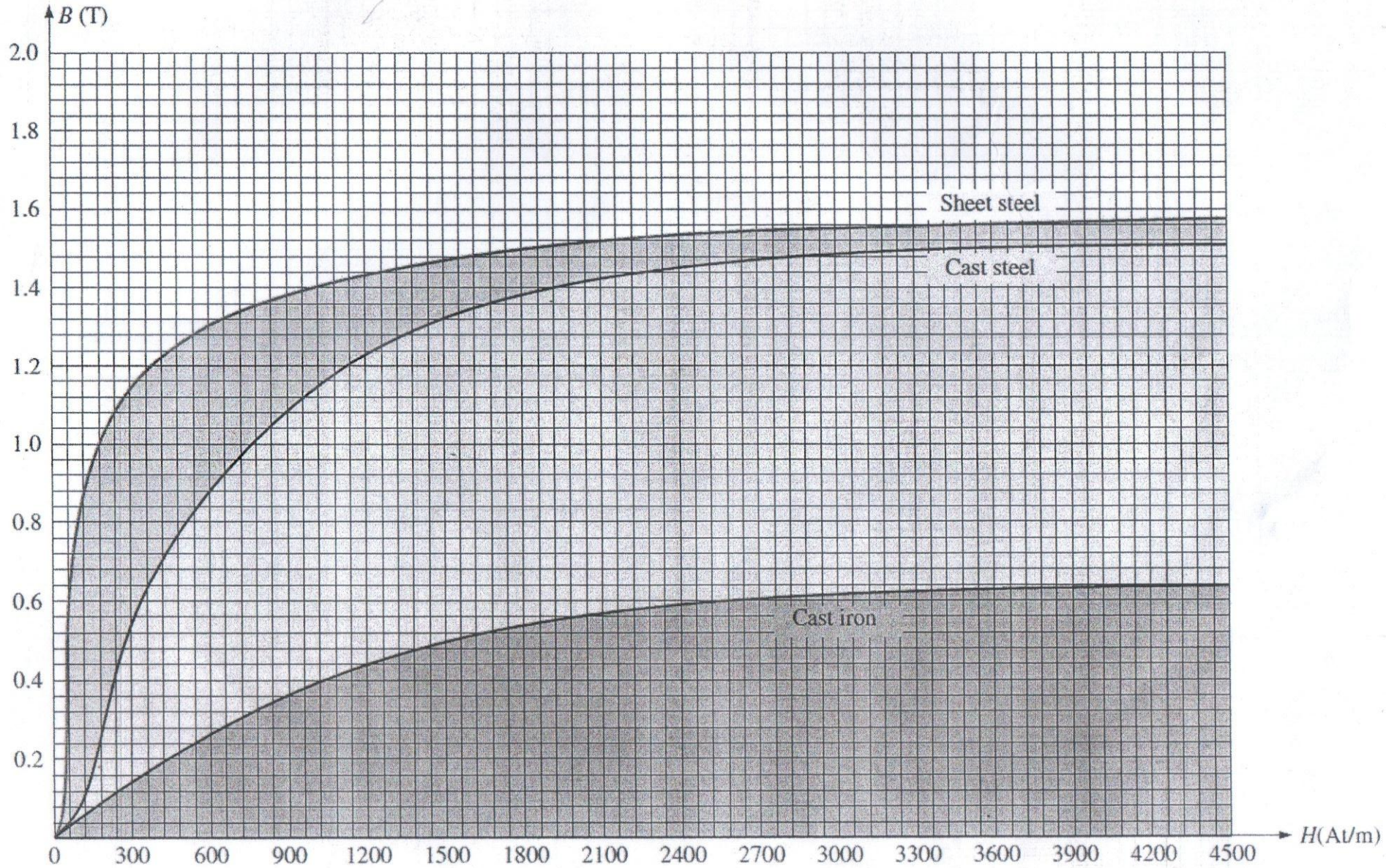


c) The energy absorbed by the BOX in the following figure is given below the box. Calculate and sketch the current flowing into the BOX. Also, calculate the charge which enters the BOX between 0 and 12 seconds. 08






B (T)
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Sheet steel
Cast steel
Cast iron
0
100
200
300
400
500
600
700
H (At/m)


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

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

Date: May 29, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

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

Winter Semester, A. Y. 2018-2019
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. Symbol(s) carry their usual meanings. Assume reasonable value if it is required.

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1. a) Show that, for a uniformly loaded d.c. distributor fed at one end, total voltage drop is equal to that produced by the whole of the load assumed to be concentrated at the middle point. 10

   b) Suppose you have to design two wire d.c. distributor AB, 600 meters long which is loaded as under: 5×3

Distance from A (meters):	150	300	350	450
Load in Amperes:	100	200	250	300

   The feeding point A is maintained at 440 V and that of B at 430 V, if each conductor has a resistance of 0.01 Ω per 100 m, calculate:
   i. Currents supplied from end A and end B,
   ii. Minimum potential and the point at which it occurs,
   iii. Power dissipated in the distributor.

2. a) Discuss briefly different types of cable faults that occurs in underground system. Murray loop test is performed to locate an earth fault in the underground system on one core of a 2 core cable 100 m long. The other core is healthy and used to form the loop. At balance, the resistance connected to the faulty core was 4 Ω. The other resistance arm has a value of 16 Ω. Calculate the distance of the fault from the test end. 6+7

   b) A single phase a.c. system supplies a load of 400 kW and if this system is converted to 3 phase 3 wire a.c. system by running a third similar conductor, calculate the 3 phase load that can now be supplied if the voltage between the conductors is the same. Assume the power factor and transmission efficiency to be the same in both the cases. 12

3. a) A 3 unit insulator string is fitted with a guard ring. The capacitance of the link pins to earth and guard ring can be assumed to be 15% and 10% of the capacitance of each unit. Determine the voltage distribution as a percentage of the line voltage to earth and string efficiency of the arrangement. 11

   b) ABCDA ring main is fed from point A at 250 V supply. Resistances for various parts (both lead and return) are as follows: 7+7

   AB = 0.02 Ω, BC = 0.018 Ω, CD = 0.025 Ω and DA = 0.02 Ω.

   Loads of 150 A, 300 A and 250 A are taken at B, C and D, respectively. Determine the voltage at each load point. If the points A and C are linked through an interconnector of resistance 0.02 Ω, determine the new voltage at each load point.

4. a) Derive the expression for sag in overhead lines when supports are at unequal levels with necessary illustration. 10

   b) A transmission line has a span of 214 m level supports. The conductors have a cross-sectional area of 3.225 cm^2. Calculate the factor of safety under the following conditions: 15
   Vertical sag = 2.35 m; Weight of conductor = 1.125 kg/m run;
   Breaking stress = 2540 kg/cm^2; Wind pressure = 1.5 kg/m run.

5. a) Discuss briefly the terms GMD and GMR of transmission line conductors. Derive the following expression of inductance of each wire for single phase two wire line. 4+8

$$L = 2*10^{-7} \ln\left(\frac{D}{r'}\right),$$

   where symbols have their usual meanings.

   b) Find the inductance per phase per km of double circuit 3 phase line shown in Fig. 5(b). The conductors are transposed and are of radius 0.75 cm each. 13

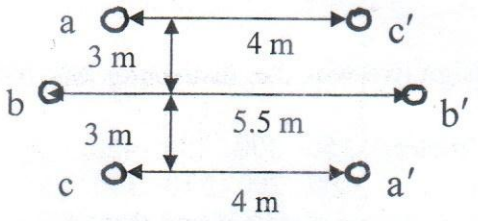

Fig. 5(b)

6. a) Discuss the difference between a.c. distribution and d.c. distribution. 8

   b) A 3-phase ring distributor ABCD fed at A at 11 kV supplies balanced loads of 40 A at 0.8 p.f. lagging at B, 50 A at 0.707 p.f. lagging at C and 30 A at 0.8 p.f. lagging at D, the load currents being referred to the supply voltage at A. The impedances per phase of the various sections are: 17
   Section AB = (1+ j2) Ω; Section BC = (2+ j3) Ω;
   Section CD = (1+ j1) Ω; Section DA = (3+ j4) Ω.
   Calculate the currents in various sections and station bus-bar voltages at B, C and D.

7. a) For medium length line, derive the generalized circuit constant A, B, C and D considering Nominal π method with necessary illustration. 12

   b) A three phase line delivers 3 MW at 11 kV line to line voltage for a distance of 15 km. Line loss is 10 % of the delivered load. Power factor is 0.8 lagging, frequency is 50 Hz. Conductors are of coppers having a resistance of 0.00137 Ω/m for a cross section of 1 mm^2 and 1.7 m equilaterally spaced. Calculate voltage regulation for the line arrangement. 13

8. a) Describe the operation of protective relays of differential type for the unit protection of distribution system. 10

   b) What is the effect of corona loss? How can you mitigate the corona loss? 4+4

   c) A three phase, 220 kV, 50 Hz transmission line has equilateral triangular spacing of side 2 m. The conductor diameter is 3 cm. The air density factor and the irregularity factor is 0.95 and 0.83, respectively. Find the disruptive critical voltage and corona loss per kilometer. 7

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B.Sc. Engg.(EE)/HDEE, 3rd Sem. Date: May 24, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A.Y. 2018-2019
Course No.: EEE 4303 — Time: 3 Hours
Course Title: Electronics II — 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. Symbols carry their usual meanings.

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1. a) What are the concepts of virtual ground and virtual short? 05

b) Derive the equation of output voltage, v_0 of the instrumentation amplifier shown in Fig. 1(b). 10

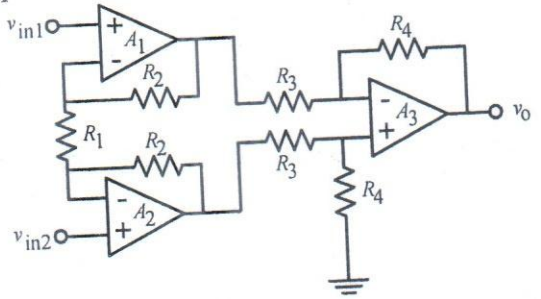

Fig. 1(b)

c) For the instrumentation amplifier in Fig. 1(b), R_4 = 90 kΩ, R_3 = 30 kΩ and R_2 = 50 kΩ. Resistance R_1 is a series combination of a fixed 2 kΩ resistor and a 100 kΩ potentiometer. (i) Determine the range of the differential voltage gain. (ii) Determine the maximum current through R_1 for input voltages in the range from -25 mV to +25 mV. 10

2. a) Consider the case of a voltage source with a 100 kΩ output impedance driving a 1 kΩ load impedance. If a voltage follower is inserted between the source and the load, then show that it will prevent loading effect. 05

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

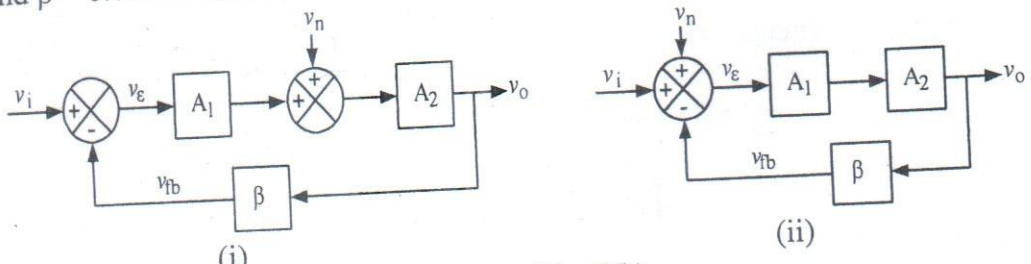

Fig. 2(b)

c) Derive the voltage transfer function of a first order active low pass filter and design it, such that the input resistance is 20 kΩ, the low-frequency gain is −15, and the −3 dB frequency is 5 kHz. 10

3. a) Draw the simplified voltage transfer characteristic of an op-amp. What are the main characteristics of an ideal op amp? 05

   b) Design a summing op-amp to produce the output $v_0 = -10v_{i1} - 4v_{i2} + 5v_{i3} + 2v_{i4}$. The smallest resistor value allowable is 20 kΩ. 10

   c) Consider the noninverting op-amp circuit in Fig. 3(c). The input resistance of the op-amp is $R_i = \infty$ and the output resistance is $R_0 = 0$, but the op-amp has a finite gain A. Derive the closed-loop transfer function in the form, $A_{vf} = \frac{v_0}{v_s} = \frac{A}{1+\beta A}$. 10

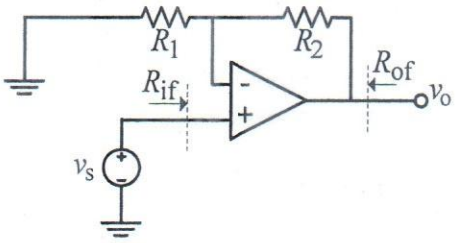

Fig. 3(c)

4. a) Draw a precision half-wave rectifier circuit and its voltage transfer characteristics using an op-amp and a diode. 05

   b) Derive the closed-loop transfer function of series–series feedback circuit shown in Fig. 4(b). 10

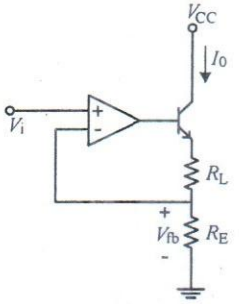

Fig. 4(b)

   c) Determine the type of feedback configuration that should be used in a design to achieve the following objectives: (i) low input resistance and low output resistance, (ii) high input resistance and high output resistance, (iii) low input resistance and high output resistance, and (iv) high input resistance and low output resistance. 10

5. a) Define filter, frequency response and bode plot. 05

   b) Draw the Bode plots (magnitude & phase) for the transfer function, $H(\omega) = \frac{5(j\omega+2)}{j\omega(j\omega+10)}$. 10

   c) Given the Bode plot in Fig. 5(c), obtain the transfer function $H(\omega)$. 10

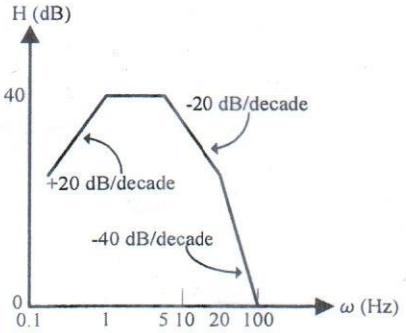

Fig. 5(c)

6. a) What is the Nyquist stability criterion for a feedback amplifier? 05

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

   c) A feedback amplifier has a low-frequency open-loop gain of 4000 and three poles at f_{P1} = 400 kHz, f_{P2} = 4 MHz, and f_{P3} = 40 MHz. A dominant pole is to be inserted such that the phase margin is 60 degrees. Assuming the original poles remain fixed, determine the dominant pole frequency. 10

7. a) Explain the two basic principles that must be satisfied in an oscillator circuit. 05

   b) Derive the expressions for the frequency of oscillation and the condition of oscillation of a Colpitts oscillator. 10

   c) Find the loop gain functions $T(s)$, the frequency of oscillation, and the R_2/R_1 required for oscillation for the circuit in Fig. 7(c). 10

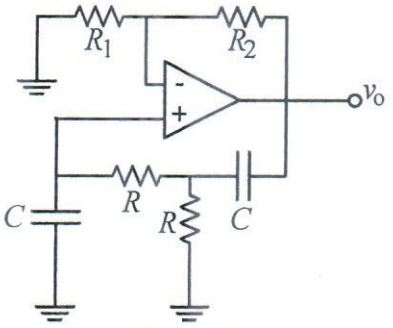

Fig. 7(c)

8. a) Draw the collector current versus time characteristics of class-A, class-B, class-AB and class-C amplifier. 05

   b) Sketch a class-AB complementary BJT push–pull output stage using a V_{BE} multiplier circuit and a two-transistor configuration using npn and pnp BJTs that are equivalent to a single pnp BJT. 10

   c) Describe the operation of a transformer-coupled class-A common-emitter amplifier and show that the maximum possible power conversion efficiency is 50 percent. 10

B.Sc. Engg. EE/ HDEE (3rd Sem.), DTE (1st Sem.) Date: 21 May, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A.Y. 2018-2019
Course No.: EEE 4305/EEE 4391 — Time: 3 Hours
Course Title: Energy Conversion I — 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. Assume suitable values for any missing data.

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1. a) A ferromagnetic core with a relative permeability of 1500 is depicted in Fig. 1(a) in which the values of all the dimensions have been incorporated. Because of the fringing effect, the effective area of each of the air gaps is 5% larger than their physical size. If $i = 1$ A, what are the flux values for left, center and right legs of the core? What is the flux density in each air gap? 20

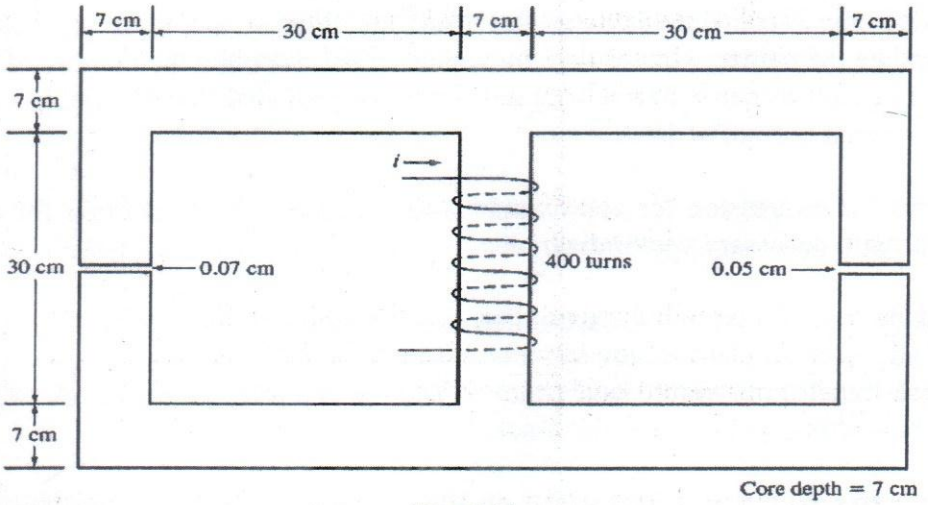

Fig. 1(a)

b) Sketch the total characteristic curve for a self-excited DC generator with accountings for all the components. 05

2. a) The following table provides the data for the O.C. test of a DC shunt generator at 300 rpm. 20

Field Amperes	0	2	3	4	5	6	7
Armature Volt	7.5	92	132	162	183	190	212

Plot the O.C.C. for 375 rpm and determine the voltage to which the machine will excite if field circuit resistance is 40 Ω.

i) What additional resistance would have to be inserted to the field coil to reduce the voltage to 200 V at 375 rpm?
ii) Without this additional resistance, determine the load current supplied by this generator when its terminal voltage is 200 V. Ignore armature reaction and assume that the speed to be constant. Armature resistance id 0.4 Ω.
iii) Determine the critical speed for this set-up.

b) What is back emf? Explain with necessary diagrams. Explain how does back emf help limiting the starting current of a DC motor? 05

3. a) Write a brief comparative analysis on the different characteristic curves of series and shunt DC motors with necessary diagrams. 10

   b) With appropriate diagrams, explain the process of voltage build up of a shunt DC generator. 10

   c) A long-shunt dynamo running at 1000 rpm supplies 22 kW at a terminal voltage of 220 V. The resistances of armature, shunt field and the series field are 0.05 Ω, 110 Ω and 0.06 Ω, respectively. Overall efficiency is 88%. Find out Cu loss, Iron and Friction loss. 05

4. a) Assume that you have been recruited as the chief engineer to repair the elevator of Star Cineplex. You identified that the speed control for the elevator is not operational and needs to be replaced. Which method of speed control you would replace it with? Explain its operation and reasons for your choice. 10

   b) What is the speed regulation of a DC motor? Briefly explain the interdependency between the torque and speed of a DC motor with proper equations and step by step analysis. 10

   c) A 4-pole DC generator supplies a current of 143 A. It has 492 wave-wound armature conductors. When delivering at full load, the brushes are given an actual lead of 10°. Calculate the demagnetizing amp-turns/pole. Also, calculate the number of extra shunt field turns needed to neutralize this demagnetization provided that the field is shunt connected and draws a current of 10 A. 05

5. a) Derive the expression for approximate voltage drop in a transformer for a lagging power factor with necessary vector diagrams. 10

   b) Imagine that you have been appointed as a transmission line engineer by your government and you need to choose between a core-type/shell-type transformer for an LV application. Which transformer would you choose? What is the primary drawback of this transformer and how would you combat this issue? 10

   c) Two series motor runs at a speed of 500 rpm and 550 rpm, respectively when both are taking 50 A at 500 V. Terminal resistance of each motor is 0.5 Ω. Calculate the speed of this combination when both of them are connected in series and coupled mechanically. The combined connection is drawing 50 A at 500 V. 05

6. a) A 5 kVA 200/1000 V, 50 Hz, single-phase transformer produced the following test results: 10
   O.C. Test (LV side): 2000V, 1.2 A, 90 W
   S.C. Test (HV side): 50 V, 5 A, 110 W
   Based on the test results obtained, calculate:
   i) The parameters of the equivalent circuit referred to the LV side.
   ii) The output secondary voltage when delivering 3 kW at 0.8 lagging power factor, the input primary voltage being 200 V.

   b) Sketch the vector diagrams for primary and secondary voltages, currents and emfs for the following load types: 10
   i) Capacitive load, incurs Cu loss, Iron loss and no leakage loss.
   ii) Inductive load, incurs Cu loss, Iron loss and leakage loss.

   c) Why do we represent the transformer rating in kVA? 05

7. a) What is the necessity of a starter circuit in a DC motor? Design and explain the operation of a DC motor starter circuit using counter-voltage sensing relays. 10

   b) Explain the chain of events which take place immediately after loading a transformer in the secondary. Attach appropriate circuit and vector diagrams to justify your explanation. 10

   c) Write down some applications of different types of motors. 05

8. a) The full load copper loss on HV side of a 100 kVA, 11000/317, 1-phase transformer is 0.62 kW and on the LV side is 0.48 KW. 10
      i) Calculate R_1, R_2 and R_2' in ohms
      ii) If total reactance is 4%, find X_1, X_2 and X_2' in ohms provided that the reactance is divided in the same ratio as the resistance.

   b) A 400 V shunt connected DC motor takes a total current of 3.5 A at no load and 59.5 A at full load. The field circuit resistance is 267 Ω and the armature resistance is 0.2 V. Voltage drop at brushes is 2 V. 10
      i) Determine the percentage change in speed from no load to full load if the armature reaction at full load weakens the flux per pole by 2%.
      ii) What resistance must be placed in series with the armature in question i) if the full load speed is to be reduced by 50% with the gross torque remaining constant? Assume that there is no change in flux.

   c) Write down the disadvantages of using rheostatic control method compared to the flux control method for speed control of a series DC motor. 05

B.Sc. Engg. (EE)/HDEE, 3rd Sem. Date: May 16, 2019 (Morning)

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

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 4307 — Time: 3 Hours
Course Title: Digital Electronics — 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) Using r's complement, ('r' represents the base) perform the subtraction operation of (i) and (ii) 09

i) $(46894)_{10}-(1883)_{10}$

ii) $(01100101)_2-(11101000)_2$

iii) Convert binary 110101 to Gray code.

(b) i) Find the complement of $F = py + yz$; then show that $F.F' = 0$ and $F + F' = 1$ 08
(ii) Show that the dual of the exclusive-OR is equal to its complement.

(c) Design a 2-bit magnitude comparator using logic gates. 08

2 (a) NAND and NOR gates can be defined as Universal gate. How? 06

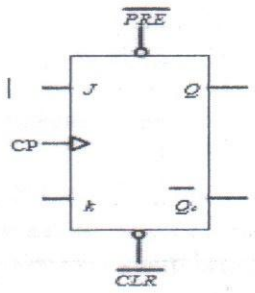
(b) A student wants to decide whether he will go home during upcoming mid semester recess by using combinational logic. He will not go if his performance in the last mid-semester exam was bad, unless his SPI (Semester Performance Index) in the previous semester was good or all his friends are going home during the recess. He will, however, go home anyway if he does not have enough money to pay his mess bill. Assign suitable Boolean variables and obtain the condition for his going home in the minimal sum of products form as well as in the minimal product of sums form. Implement the functions by 2 input NAND gate only. Also realize it by 2:1 MUX. 09

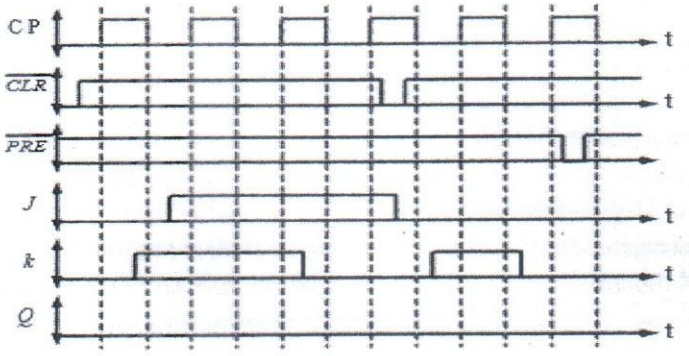
(c) Realize the following function of four variables using: 10
(i) 8:1 Multiplexers and
(ii) 4:1Multiplexers.

$$F = A\overline{B}\,\overline{C}D + AB\,\overline{C}D + A\overline{B}C\overline{D} + \overline{A}B\,\overline{C}\,\overline{D} + A\overline{B}\,\overline{C}\,\overline{D}$$

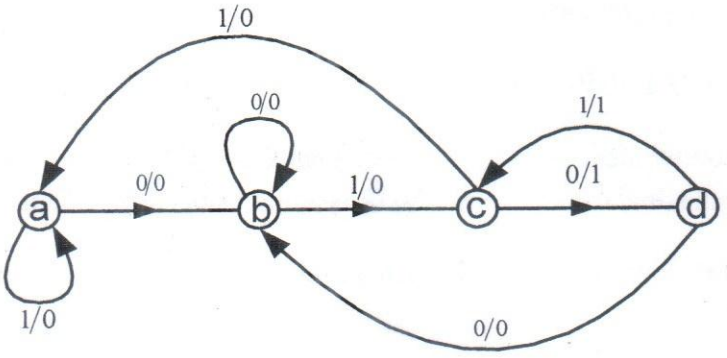
3 (a) Show the operation of a basic flip-flop circuit. 05

(b) For a positive edge-triggered J-K flip-flop with Preset and Clear inputs as shown bellow, determine the Q output relative to the clock pulse (CP). What is the role of Preset and Clear inputs here? 10



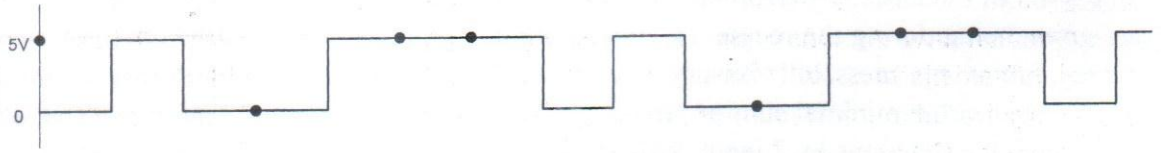


(c) Design a clocked sequential circuit using J-K flip-flop for the state diagram shown in the following figure: 10



4 (a) Design a J-K counter for state 0, 8, 9, 5, 10, 12, 14, 15, 0... 13

(b) Design a pulse train generator for the following wave form using J-K flip flop. 12



5 (a) What is meant by a free-running multi-vibrator. Draw the input-output transfer curve of 555 timer. 06

(b) Design a 100 kHz (1) 60% and (ii) 50% duty cycle square-wave generator using 555 timer with necessary passive elements. 12

Sketch the voltage wave shape across the capacitor in the same time scale of output voltage wave shape. Derive the necessary equation. Use the capacitor $C = 4.67\,nF$.

(c) Design a one-shot mono-stable multi-vibrator using 555 timer, to generate a 5ms. pulse using $1k\Omega$ resistor. Sketch the voltage wave shape across the capacitor in the same time scale of output voltage wave shape when trigger is applied at t = 5 ms. Derive the necessary equation. 07

6 (a) Define encoder. Distinguish between encoder and decoder. Design a encoder circuit for 10 line to 4 line priority encoder. 06

(b) Implement the following multi-output combinational logic circuit decoder using logic gates: 10

$$F_1 = A\overline{B}CD + AB\overline{C}D + AB\overline{D} + \overline{A}BC\overline{D} + \overline{B}\,\overline{C}D$$

$$F_2 = \sum m\,(2,3,9,11),\ F_3 = \sum m\,(10,12,13,14),\ F_4 = \sum m\,(2,4,8),$$

(c) Design a 4 bit BCD asynchronous down counter using any flip flop. Show the timing diagram of each output relative to the negative edge clock pulse. 09

7 (a) Determine the following for $16k\times8$ RAM. 05

i) Number of address lines required

ii) Number of words in this memory

iii) Number of bits in each word

iv) Total number of bits in the memory

(b) Determine how many $16k\times4$ memory circuits would be required to construct a memory of each given capacity. 06

i) $256k\times8$

ii) $128k\times16$

iii) $1M\times4$

(c) A $2k\times8$ memory is to be constructed using 256×8 memory chips, each of which has an active low chip select and R/W lines. Mention the address of each chip. 14

(i) How many 256×8 memory chips are required?

(ii) What type of decoder is necessary to select the individual 256×8 chip?

Draw the necessary diagram for the system, showing the address, data and $R/\overline{W}$ lines. Mention the address of each chip.

8 (a) Design a sequence detector using shift register for the sequence: 10111. 06

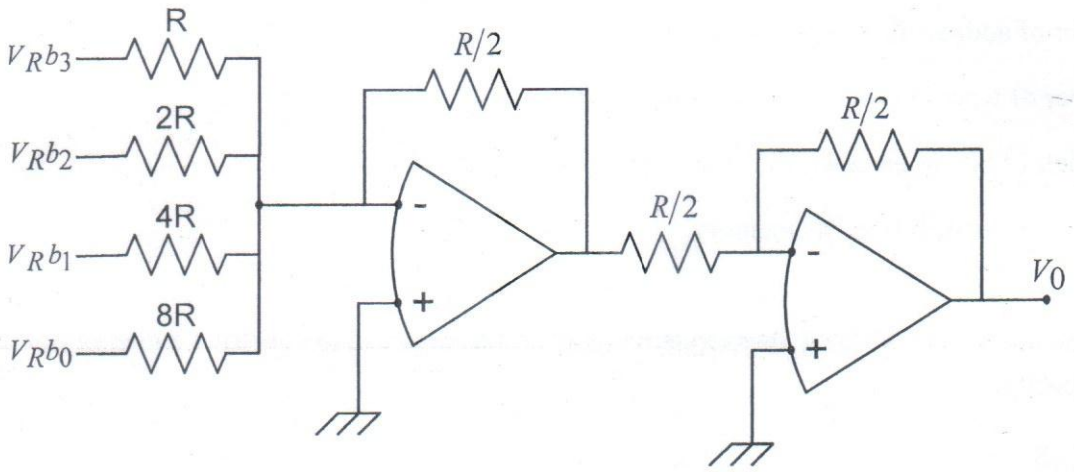
(b) The analog output of a five bit DAC converter for a digital input 00001 is found to be 10 mV. Find its maximum full scale output, resolution and percent resolution. 06

(c) For the circuit of a 4-bit binary weighted resister DAC using op-amp shown in the diagram below, find the analog output voltage V_0, (Derive the necessary equation) when 13

(i) all the bits are set to 1,

(ii) only LSB is 1,

(iii) the step height, where $V_R = 8$ Volts.



BScME, 3rd Sem.

Date: May 20, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: Phy 4313
Course Title: Basic Electronics and Semiconductor Physics

Winter Semester, A. Y. 2018-2019
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) Draw the labelled diagram of diode characteristics for both Si and Ge diodes on the same diagram. 5

   b) For the zener diode network of Fig. 1(b), (i) determine V_L, V_R, I_Z and P_Z considering $V_Z = 12$ V and $P_{ZM} = 40$ mW. (ii) Repeat part (i) with $R_L = 15$ kΩ. 14

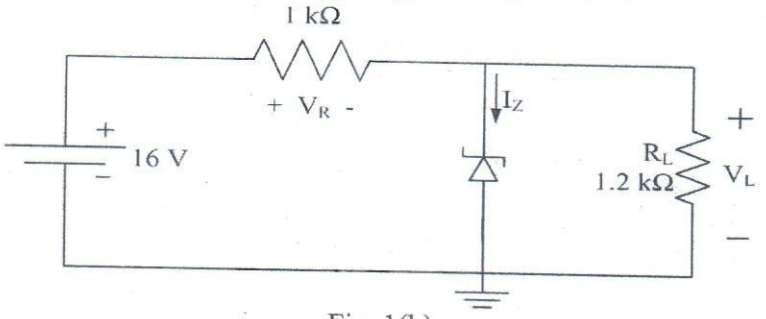

Fig. 1(b)

   c) Define PIV, Reverse Saturation Current and Zener Voltage. 6

2. a) Draw the input and output voltage wave shapes for the circuits in Fig. 2(a) - (d). Consider $V_{in} = 10$ $V_{p\text{-}p}$, R = 1 kΩ and V = 2 V. 14

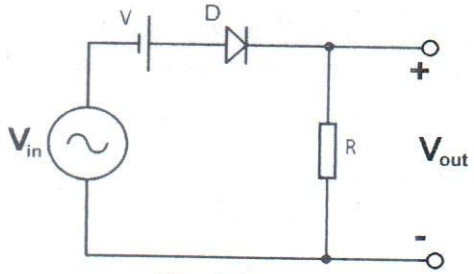

Fig: 2(a)

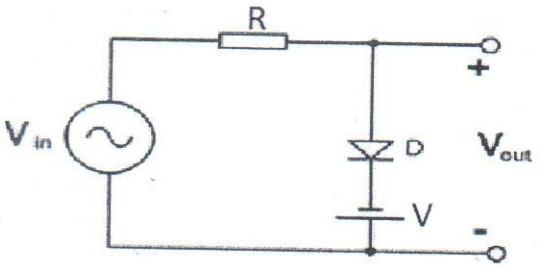

Fig: 2(b)

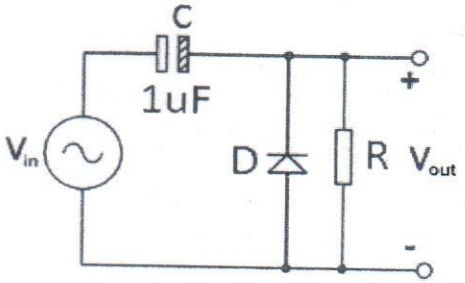

Fig: 2(c)

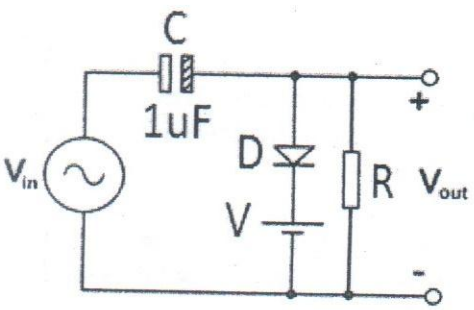

Fig: 2(d)

b) A full wave rectifier with center-tapped transformer has a 120 V_{peak} sinusoidal input and a load resistor of 1 kΩ. 11

i. Draw the circuit diagram.
ii. Sketch the input and output wave shapes considering silicon diodes (V_{th} = 0.7 V).
iii. Determine the dc voltage at the output considering ideal diodes.
iv. What are the additional elements required to reduce the ripple at the output?

3. a) What is the major difference between a bipolar and unipolar semiconductor device? What kind of device a BJT is and why? 5

b) What are the modes of operation of a transistor? Write down the biasing condition of two junctions for each mode. How must the two junctions be biased for proper transistor amplification operation? 8

c) Determine the dc bias voltage V_{CE}, collector current I_C, base voltage V_B, output voltage V_O for the configuration of Fig. 3(c). Consider β = 45. 12

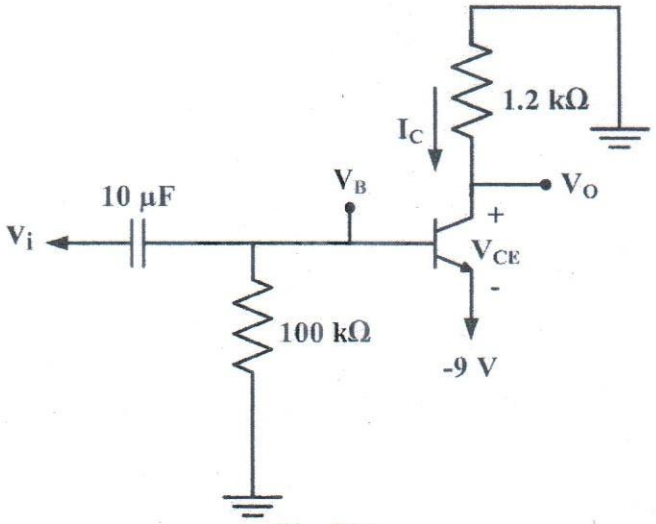

Fig. 3(c)

4. a) What is the significant difference between the construction of an enhancement-type MOSFET and a depletion-type MOSFET? Briefly describe the basic operation of a depletion-type MOSFET. 10

b) Sketch the drain characteristic curve for both *n*-channel and *p*-channel enhancement type MOSFET. Also, sketch the transfer curve for an n-channel depletion type MOSFET with I_{DSS} = 10 mA and V_P = - 4 V. 10

c) Describe the process of reduction in free carriers in the channel due to negative potential at the gate terminal of an n-channel depletion type MOSFET. 5

5 a) Draw the basic construction of a *n*-channel JFET. Apply proper biasing between drain and source. Sketch the depletion region for V_{GS} = 0 V. Also, sketch the transfer curve with I_{DSS} = 12 mA and V_P = -6 V using shorthand method. 13

b) Design an astable multivibrator to produce a positive cycle of 1 ms and a negative cycle of 3 ms at the output. Show necessary calculations and sketch necessary waveshapes. 12

6. a) What is an op-amp? Write down the pin configuration of LM-741 op-amp IC. 5

   b) Implement the equation using op-amps: 12

$$5x_1 - 6x_2 + 2\frac{dy}{dt} + 3\int x_3 dt + \frac{dx_4}{dt} = 0$$

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

   c) A triangular wave of amplitude 2V and time period 4s are used as the input of a differentiator. Draw the circuit diagram, input and output wave shapes if the value of the resistor and capacitor are 10 kΩ and 0.2 μF, respectively. Show necessary calculations. 8

7. a) Draw the circuit diagram of an Analog to Digital converter and describe the method of operation. 12

   b) Design a 4-bit R/2R Ladder Digital to Analog converter and find the output voltage for inputs 0100 and 0101. 13

8. a) Convert the numbers: 8

   i. $(76590367)_{10} = (\ ?\ )_{16}$,
   ii. $(10001101)_{10} = (\ ?\ )_{8}$,
   iii. $(18BCA8F)_{16} = (\ ?\ )_{8}$,
   iv. $(10110001)_{8} = (\ ?\ )_{10}$.

   b) Describe the differences between analog and digital signals using appropriate example. 5

   c) Design an 8-bit to 3-bit encoder using digital logic gates. Formulate the truth table. Derive the expressions and implement them using logic gates. 12

B.Sc. Engg. (EEE)/3rd Sem, B ScTE(2 Y, 1st Sem.) 27 May, 2019 (Morning)

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

Semester Final Examination — Winter Semester, A.Y.: 2018-2019
Course No.: Math 4321 — Time : 3 hours
Course Title: Transform Techniques and Linear Algebra — Full Marks: 150

There are 8 (Eight) questions. Answer any 6 (Six) questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The Symbols have their usual meaning

---

1. (a) Show that $erf(\sqrt{t}) = \dfrac{1}{s\sqrt{s+1}}$ (12)

   (b) $L\{\cos t\, Si(t) - \sin t\, Ci(t)\} = \dfrac{\ln s}{s^2+1}$ (13)

2. Use Laplace transform to solve the following

   (a) $Y''(t) + Y'(t) - 2Y(t) = \sin t, \quad Y(0) = Y'(0) = 0$ (12)

   (b) An inductor of 2H, a resistor of 16 ohms and a capacitor of 0.02F are connected in series with an e.m.f. of E volts. At $t=0$ the charge on the capacitor and current in the circuit are zero. Find the charge and current at any time t >0 if E=300 V. (13)

3. (a) Expand $f(x) = x + x^2, \; -\pi < x < \pi$ in Fourier series. (14)

   (b) Expand $f(x) = \begin{cases} 1 + \dfrac{x}{\pi}, & -\pi < x < 0 \\ 1 - \dfrac{x}{\pi}, & 0 < x < \pi \end{cases}$ in Fourier cosine series. (11)

4. (a) Expand f(x) = x, 0 < x < 2, in a (i) half range sine series and then (ii) half range cosine series. (13)

   (b) Sketch the even extension of the function $f(x) = \sin x$, $0 < x < \pi$ and then expand in a Fourier cosine series. (12)

5. (a) Find the standard matrix for the transformation T on R^3 , where T is the composition of a rotation of 45° about y-axis, followed by an orthogonal projection on xz-plane, followed by a dilation with factor $k = \sqrt{2}$. Then find T(3, – 4, 7) using the standard matrix. (15)

(b) Show that, the linear transformation T on R^2 defined by the following equations is one-to-one, and find $T^{-1}(w_1, w_2)$. (10)

$$w_1 = 2x + y$$
$$w_2 = 3x + 4y$$

6. (a) What is Linear Span? Determine whether the vectors $v_1 = (3, 1, 4)$, $v_2 = (2, -3, 5)$, $v_3 = (5, -2, 9)$, $v_4 = (1, 4, -1)$ span R^3. (12)

(b) Consider the basis $S = \{v_1, v_2, v_3\}$ for R^3 , where $v_1 = (1, 1, 1)$, $v_2 = (1, 1, 0)$, and $v_3 = (1, 0, 0)$. Let $T: R^3 \rightarrow R^3$ be the linear transformation such that $T(v_1) = (2, -1, 4)$, $T(v_2) = (3, 0, 1)$, $T(v_3) = (-1, 5, 1)$. Find a formula for T(x,y,z); then compute T(2, ,4 - 1) using the formula. (13)

7. (a) Let the linear transformation defined by:
$T(x,y,z) = (x-y+3z, 5x+6y-4z, 7x+4y+2z)$
Find (i) Range(T) and (ii) Kernel(T) and then verify the dimension theorem. (13)

(b) Describe the Kernel and Range of the orthogonal projection on the x = y plane. Then verify the dimension theorem. (12)

8. (a) Determine whether the following matrix is diagonalizable. If so, find a nonsingular matrix P that diagonalizes A, and write down the diagonal matrix D so that $P^{-1}AP = D$. (11)

$$A = \begin{bmatrix} 5 & 3 & -1 \\ 3 & 5 & -1 \\ -3 & -3 & 3 \end{bmatrix}.$$

(b) Find the QR-decomposition of $A = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix}$ using Gram–Schmidt process. (14)

B.Sc. Engg. (EEE)/3rd Sem, B ScTE(2 Y, 1st Sem.) 27 May, 2019 (Morning)

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

Semester Final Examination — Winter Semester, A.Y.: 2018-2019
Course No.: Math 4321 — Time : 3 hours
Course Title: Transform Techniques and Linear Algebra — Full Marks: 150

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Find (i) Range(T) and (ii) Kernel(T) and then verify the dimension theorem. (13)

(b) Describe the Kernel and Range of the orthogonal projection on the x = y plane. Then verify the dimension theorem. (12)

8. (a) Determine whether the following matrix is diagonalizable. If so, find a nonsingular matrix P that diagonalizes A, and write down the diagonal matrix D so that $P^{-1}AP = D$. (11)

$$A = \begin{bmatrix} 5 & 3 & -1 \\ 3 & 5 & -1 \\ -3 & -3 & 3 \end{bmatrix}.$$

(b) Find the QR-decomposition of $A = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix}$ using Gram–Schmidt process. (14)

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B.Sc. Engg. (CSE), 3rd Sem. Date: 15 May, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A.Y. 2018-2019
Course No.: EEE 4383 — Time: 3 Hours
Course Title: Electronic Devices and Circuits — 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. Assume suitable value for any missing data.

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1. a) Write down a comparative analysis on the characteristics of BJT and FET. 05

   b) What is the pinch-off voltage for a JFET? Explain this phenomenon for an n-channel JFET with appropriate diagrams. What is the condition for obtaining pinch-off voltage for this kind of set-up? 10

   c) What is a voltage-controlled resistor? When and how a JFET can be used as a voltage controlled resistor? Justify your answer. 05

   d) Draw the circuit diagrams of an n-channel JFET with appropriate values of the drain voltage, gate voltage, drain current and gate current for the following states: 05
      i) Saturation
      ii) Pinch-off.

2. a) What is Shockley's equation? Draw the transfer characteristics of an n-channel JFET. 10

   b) Given that, for a JFET device, I_{DSS} = 12 mA and V_P = 4 V. Sketch the transfer characteristics curve for the device. 05

   c) What is an SCR? Draw the equivalent BJT model of an SCR from its basic semiconductor build. What is the function of the gate terminal in an SCR? 05

   d) What are the methods for turning off an SCR? Explain them with appropriate circuit diagrams. 05

3. a) Explain the basic operation of an enhancement type n-channel MOSFET with proper diagrams. 10

   b) Sketch the transfer characteristics curve for an n-channel depletion type MOSFET with I_{DSS} = 10 mA and V_P = -4 V. 05

   c) Explain the differences between DIAC and TRIAC along with their transfer curves and equivalent circuit diagrams. 05

   d) What is an active filter? What is the cut-off frequency for a low pass filter? Sketch the circuit diagram for a first-order low pass active filter and derive its cut-off frequency. 05

4. a) Explain the construction of a CMOS with appropriate diagram. 05

   b) What is the threshold voltage of a MOSFET? What is its significance? 05

   c) Assuming the diodes in the circuit of Fig. 4(a) are ideal, find out V and I. 10

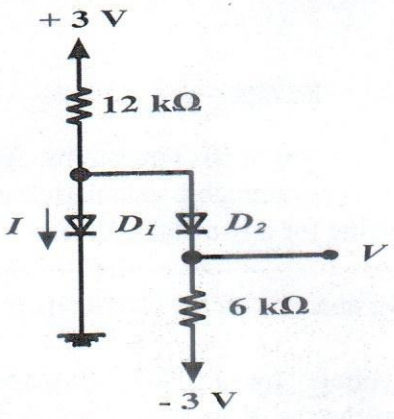

Fig. 4(a)

   d) What is the bandwidth of a filter? Design a band pass active filter. 05

5. a) What is a PJT? Sketch and explain the transfer characteristics curve of a UJT with equivalent circuit diagram and equations. How does an UJT differ from an SCR? 10

   b) What is voltage regulation? Design an improved version of a series voltage regulator and describe its operation. 05

   c) Why and how does the saturation voltage of an enhancement type MOSFET change with the gate to source voltage? 05

   d) For a bridge network, draw the output wave-shape in case of full-wave rectification. Determine the values of V_{dc}. (Consider non-ideal diodes) 05

6. a) Draw the h-equivalent circuit diagrams of an n-p-n BJT. 05

   b) Sketch the direction current flow in a p-n-p transistor biased to operate in active mode along with their causes of origin. 05

   c) Derive the expression for voltage gain of an n-p-n transistor in common-emitter configuration. 05

   d) What is the purpose of DC biasing in BJT? 05

   e) What is Q-point? Describe the significance of biasing in case of fixing a Q-point and its effect on amplification in a common-emitter connection for small signals. 05

7. a) What are the functions of stabilizers and UPS? Sketch the basic block diagram for a regulated power supply. 05

   b) What are the advantages of using the difference mode of inputs in op-amp? 05

   c) Derive the equations and draw the circuit diagram to represent the source signals of an ideal op-amp in terms of their differential and common mode components. 05

d) What is a difference amplifier? Describe the working principle of a difference amplifier with proper diagrams. 10

8. a) For the circuit in Fig. 8(a), I_{DSS} = 6 mA and V_P = -3 V, calculate the values of I_{DQ}, V_{GSQ}, V_D and V_S. Also draw the graph for Q-point. 10

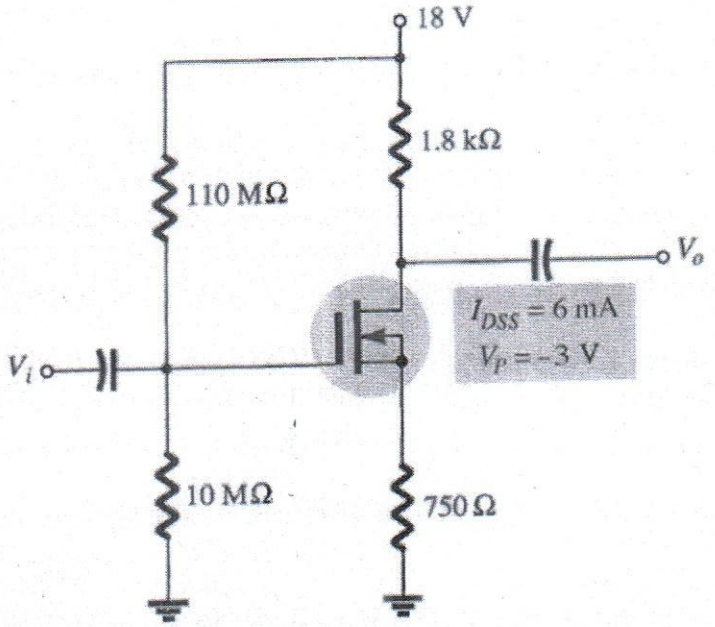

Fig. 8(a)

b) Draw the circuit diagram of a differentiator and an integrator? 05

c) What is the virtual ground for an op-amp? 05

d) What are α and β for a BJT. Derive the expression by which α and β are related to each other. 05

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B.Sc. Engg.(CEE), 3rd Sem. Date: May 24, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A.Y. 2018-2019
Course No.: EEE 4385 — Time: 3 Hours
Course Title: Electrical and Electronic Technology — 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. Symbols carry their usual meanings.

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1. a) Use nodal analysis to find V_0 in the circuit of Fig. 1(a). 7

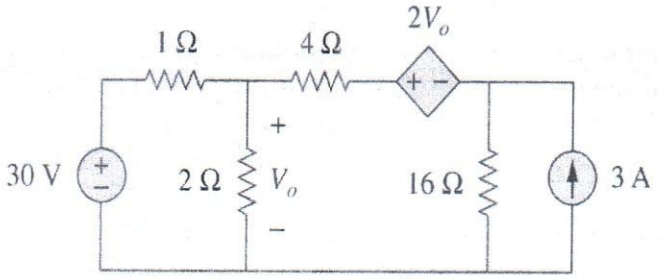

Fig. 1(a)

b) Use mesh analysis to find i_0 in the circuit of Fig. 1(b). 10

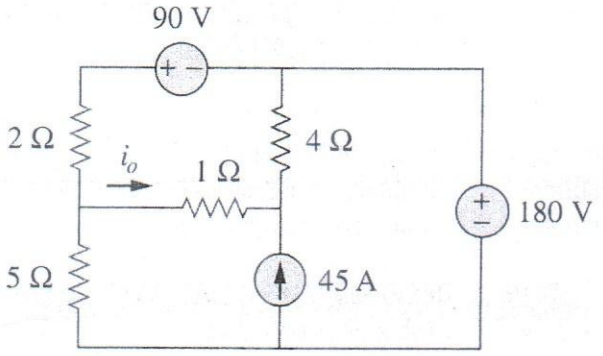

Fig. 1(b)

c) Using superposition principle, find the V_0 in the circuit of Fig. 1(c). 8

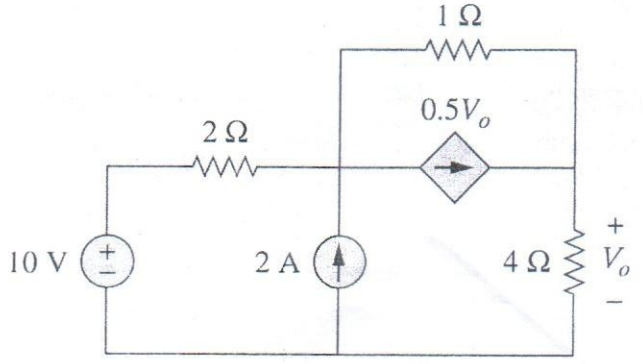

Fig. 1(c)

2. a) Obtain the equivalent Thevenin circuit at terminals a - b of the circuit in the Fig. 2(a). 12

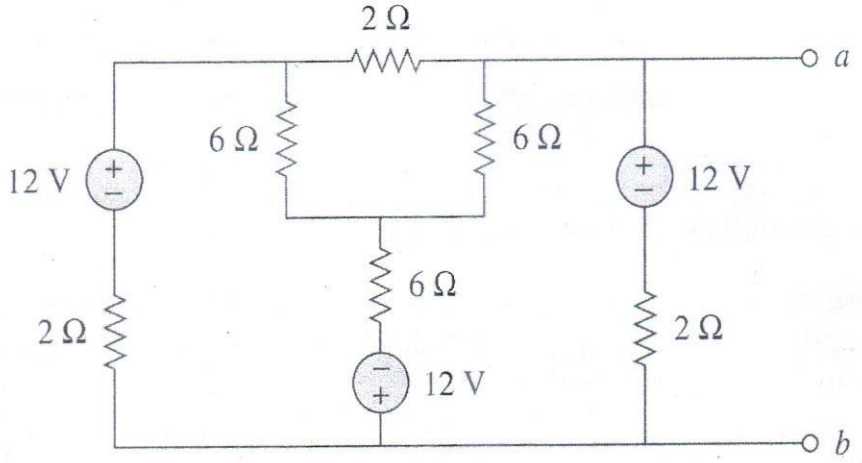

Fig. 2(a)

b) Determine the Norton equivalent of the circuit at terminals a-b in Fig. 2(b). 13

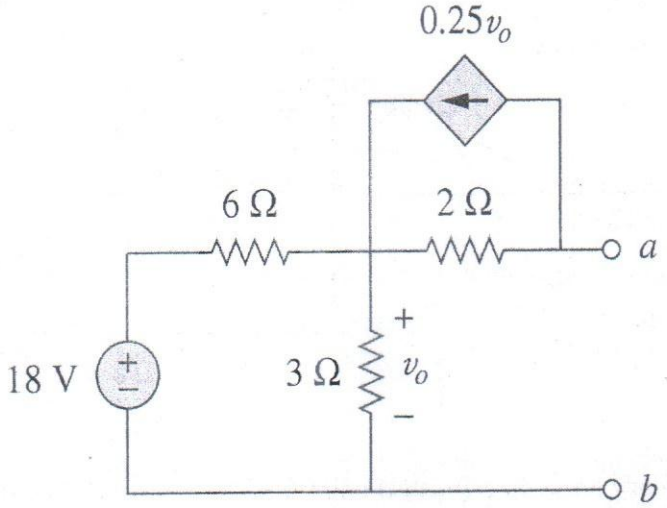

Fig. 2(b)

3. a) Use nodal analysis to find v_o in the circuit of Fig. 3(a), for $\omega = 2$ krad/s. 8

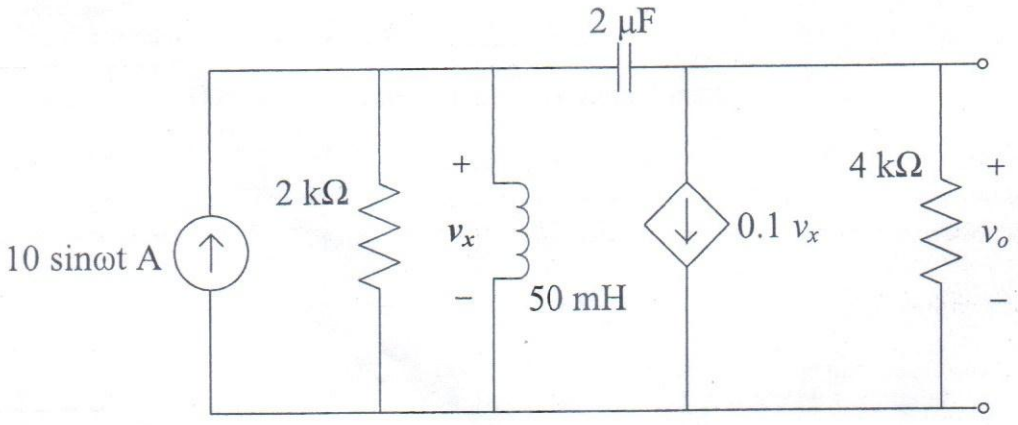

Fig. 3(a)

b) What is admittance? Find I in the circuit of Fig. 3(b). 7

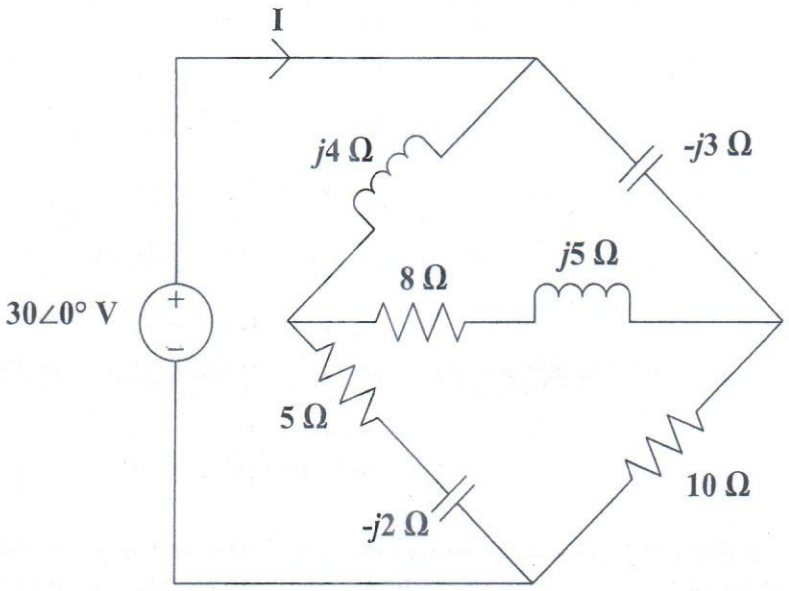

Fig. 3(b)

c) Determine current I_0 in Fig. 3(c) using Norton's theorem. 10

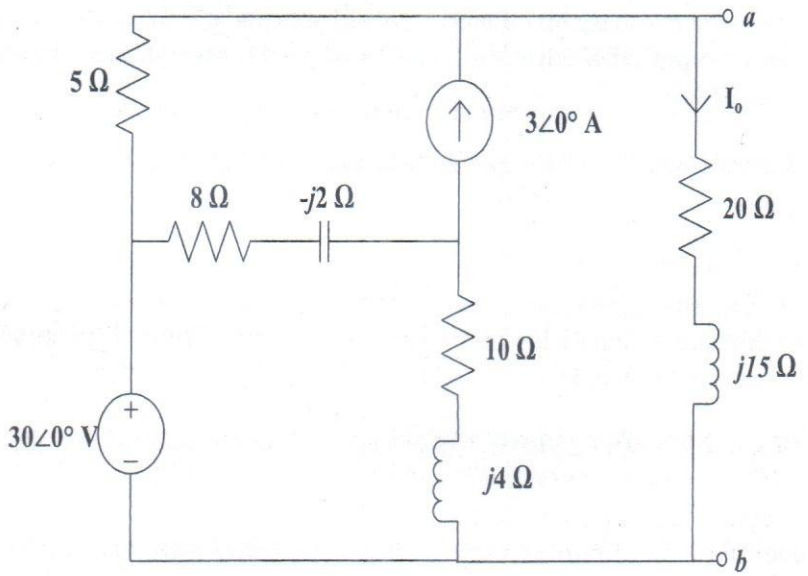

Fig. 3(c)

4. a) The following information is given for 300 kW, 600 V, long-shunt compound generator: shunt field resistance is 75 Ω, armature resistance including brush resistance is 0.003 Ω, commutating field winding resistance is 0.011 Ω, series field resistance is 0.012 Ω, divertor resistance is 0.036 Ω. When the machine is delivering full load, calculate the voltage and the power generated by the armature. 7

b) Summarize all the losses in a generator. Prove generator efficiency is maximum when variable losses is equal to constant losses. 8

c) A shunt generator gave the following open circuit characteristics : 10

Field current (A)	0.5	1.0	1.5	2.0	2.5	3.0	3.5
O.C. voltage (V)	54	107	152	185	210	230	245

The armature and the field resistances are 0.1 Ω and 80 Ω respectively. Calculate the followings :

i. The voltage to which the machine will excite when run as a shunt generator at the same speed.

ii. The voltage drop due to armature reaction when 100 A is passing in the armature at a terminal voltage of 175 V.

5. a) What is torque? For a d.c. shunt motor, prove that the armature torque is 8

$$T_a = 9.55 \frac{E_b I_a}{N} \ (N-m)$$

b) A 4 pole d.c. shunt motor has a flux per pole of 0.04 Wb and the armature is lap wound with 720 conductors. The shunt field resistance is 240 Ω and the armature resistance is 0.2 Ω. Brush contact drop is 1.0 V per brush. Determine the speed of the machine when running as a motor taking 60 A and the terminal voltage is 480 V. 5

c) Derive the condition for maximum power for a motor. 5

d) Write down the comparison between electric braking and mechanical braking? What are the different types of electric braking? Write down their names with their advantages and disadvantages. 7

6. a) What is a transformer? What are the types of transformer? Why the transformer rating is in kVA? 5

b) A 25 kVA transformer has 500 turns on the primary and 50 turns on the secondary winding. The primary is connected to 3000 V, 50 Hz. Find the full load primary and secondary currents, the secondary emf and the maximum flux in the core. Neglect leakage drops and no load primary current. 8

c) A 20 kVA, 2500/250 V, 50 Hz, 1-phase transformer has the following test results: 12
O.C. Test (l.v. side) : 250 V, 1.4 A, 105 W
S.C. Test (h.v. side) : 104 V, 8 A, 320 W
Compute the parameters of the approximate equivalent circuit referred to the low voltage side and draw the circuit.

7. a) Define slip. Derive the condition for maximum torque under running conditions of a three-phase induction motor. 5

b) A 150 kW, 3000 V, 50 Hz, 6 pole star connected induction motor has a star connected slip-ring motor with a transformation ratio of 3:6 (star/rotor). The rotor resistance is 0.1 Ω/phase and its per phase leakage inductance is 3.61 mH. The starter impedance may be neglected. Find the starting current and starting torque on rated voltage with short circuited slip rings. 10

c) What is an alternator? What are the conditions for connecting a new alternator in parallel with an existing alternator? 10

8. a) Determine V_0 for each network of Fig. 8(a) for the input shown below. 6

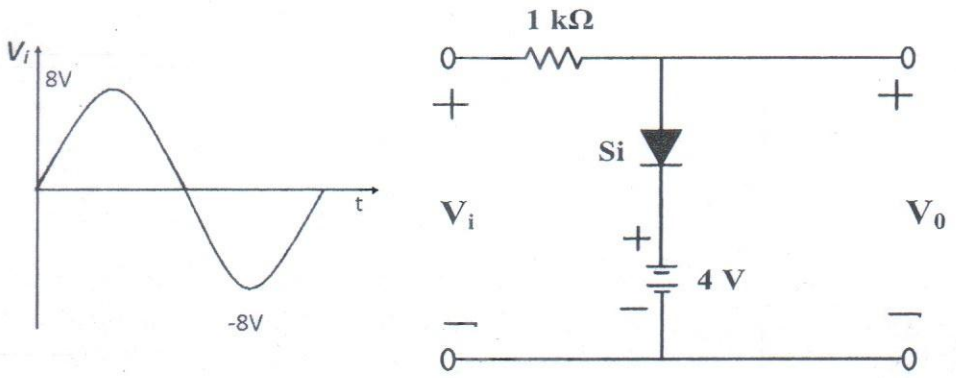

Fig. 8(a)

b) Sketch V_0 for the network of Fig. 8(b) and determine the dc voltage available. 9

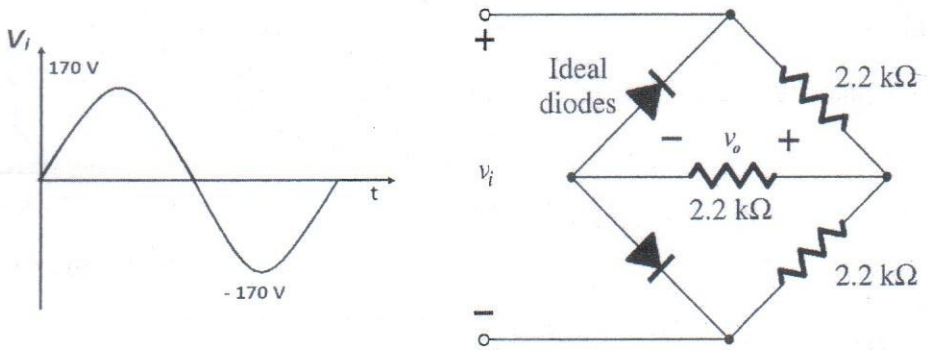

Fig. 8(b)

c) Determine I, V_1, V_2 and V_0 for the series configuration of the circuit shown in Fig. 8(c). 10

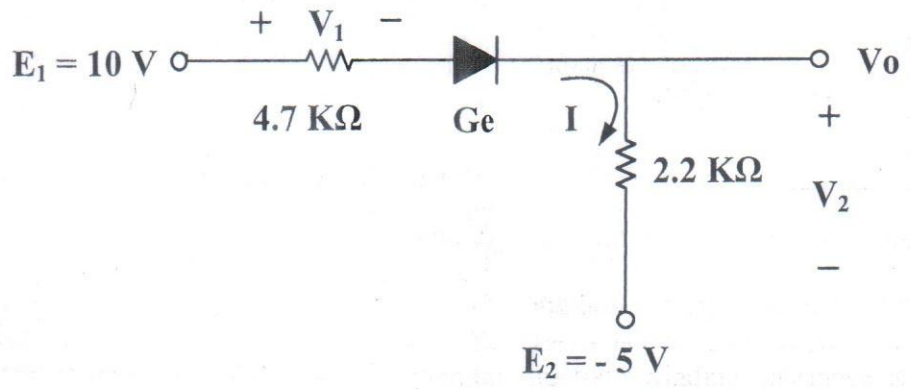

Fig. 8(c)

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B.Sc. Engg.(EE)/HDEE, 5th Sem. Date: 20 May, 2019(Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 4501 — Time: 150 Minutes
Course Title: Electromagnetic Fields and Waves — Full Marks:150

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

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1. a) Mention few important Engineering applications of electrostatics. Show that the electrostatic field $\vec{E}$ is conservative or irrotational ($\vec{\nabla} \times \vec{E} = 0$). 5

   b) Two infinite uniform line charges of density 5 μC/m lie along the x and y axes in free space are shown in Fig. 1(b). Find the electric field $\vec{E}$ at (i) $P_A(0,0,4)$ and (ii) $P_B(0,3,4)$. All coordinate values are in meter. 10

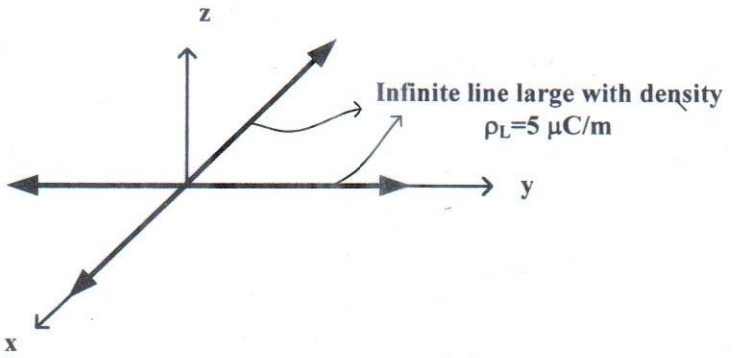

Fig. 1(b)

   c) Given the surface charge density, $\rho_s = 2\mu C/m^2$, existing in the region $\rho < 0.2$ m, $z = 0$ find $\vec{E}$ at (i) $P_A(\rho = 0, z = 0.5)$; (ii) $P_B(\rho = 0, z = -0.5)$. Show that (iii) the field along the z axis reduces to that of an infinite sheet charge at small values of z; (iv) the z axis field reduces to that of a point charge at large values of z. 10

2. a) Describe Faraday's experiment that established the concept of electric flux density $\vec{D}$. What is the difference between $\vec{D}$ and charge density? 5

   b) A uniform volume charge density of 80 μC/m^3 is present throughout the region 8 mm $< r <$ 10 mm. Let $\rho_v = 0$ for $0 < r <$ 8 mm. (i) Find the total charge inside the spherical surface r = 10 mm. (ii) Find $\vec{D}$ at r = 10 mm. (iii) If there is no charge for $r >$ 10 mm, find $\vec{D}$ at r = 20 mm. 10

   c) A cube is defined by $1 < x, y, z < 1.2$. If $\vec{D} = 2x^2y\vec{a}_x + 3x^2y^2\vec{a}_y$ C/m^2, (i) apply Gauss's law to find the total flux leaving the closed surface of the cube, (ii) evaluate $\vec{\nabla} \cdot \vec{D}$ at the center of the cube and (iii) estimate the total charge enclosed within the cube. 10

3. a) Define potential and potential gradient. Show that the $\vec{E} = -\vec{\nabla} V$. 8

b) A spherically-symmetric charge distribution in free space (with a < r < ∞) is known to have a potential function $V(r) = V_0 a^2 / r^2$, where V_0 and a are constants. Find (i) the electric field intensity, (ii) the volume charge density, (iii) the charge contained inside radius a and (iv) the total energy stored in the charge. 12

c) A dipole having a moment $\vec{p} = 3\vec{a}_x - 5\vec{a}_y + 10\vec{a}_z$ nC · m is located at $Q(1, 2, -4)$ in free space. Find V at $P(2, 3, 4)$. 5

4. a) Derive the equation for continuity current. Given that the current density $\vec{J} = -10^{-4}(y\vec{a}_x + x\vec{a}_y)$ A/m^2, find the current crossing the $y = 0$ plane in the $-y$ direction between $z = 0$ and 1, and $x = 0$ and 2. 12

b) Let Region 1 (z < 0) be composed of a uniform dielectric material for which $\varepsilon_r = 3.2$, while Region 2 (z > 0) is characterized by $\varepsilon_r = 2$. Let $\vec{D}_1 = -30\vec{a}_x + 50\vec{a}_y + 70\vec{a}_z$ nC/m^2. Find: (i) D_{N1}, (ii) $\vec{D}_{N2}$, (iii) $\vec{D}_{t1}$, (iv) $\vec{D}_{t2}$, (v) θ_1 and (vi) $\vec{P}_2$. 13

5 a) Derive Poisson's equation. 5

b) A large brass washer has a 2 cm inside diameter, a 5 cm outside diameter, and is 0.5 cm thick. Its conductivity is σ = 1.5 × 107 S/m. The washer is cut in half along a diameter, and a voltage is applied between the two rectangular faces of one part. The resultant electric field in the interior of the half-washer is $\vec{E} = (0.5/r)\vec{a}_\varphi$ V/m in cylindrical coordinates, where the z axis is the axis of the washer. (i) What potential difference does exist between the two rectangular faces? (ii) What is the total current flowing? (iii) What is the resistance between the two faces? 12

c) Consider a coaxial capacitor having inner radius ***a***, outer radius ***b***, unit length and filled with a material with dielectric constant, ε_r. Compare this to a parallel-plate capacitor having plate width ***w***, plate separation ***d***, filled with the same dielectric and having unit length. Express the ratio ***b/a*** in terms of the ratio ***d/w***, such that the two structures will store the same energy for a given applied voltage. 8

6 a) State Ampere's circuital law. Using Ampere's circuit law, find the magnetic field intensity $\vec{H}$ in all regions of the coaxial cable shown in Fig. 6(a) and sketch the $\vec{H}$ versus r. 13

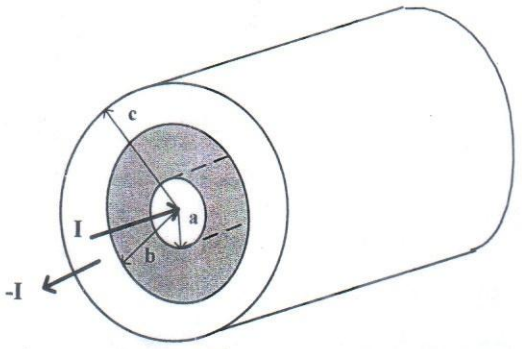

Fig. 6(a)

b) The magnetic field intensity is given in a certain region of space as $\vec{H} = [(x+2y)/z^2]\vec{a}_y + (2/z)\vec{a}_z$ A/m. Find $\vec{\nabla} \times \vec{H}$ and the total current passing through the surface at z = 4 and $1 \le x \le 2, 3 \le z \le 5$ in the $\vec{a}_z$ direction. 12

7 a) Find the amplitude of the displacement current density: (i) adjacent to an automobile antenna where the magnetic field intensity of an FM signal is $\vec{H} = 0.15 \cos[3.12(3 \times 10^8 t - y)]\vec{a}_x$ A/m; (ii) in the air space at a point within a large power distribution transformer where, $\vec{B} = 0.8 \cos[1.257 \times 10^{-6}(3 \times 10^8 t - x)]\vec{a}_y$ T; (iii) within a large, oil-filled power capacitor where $\varepsilon_r = 5.0$ and $\vec{E} = 0.9 \cos[1.257 \times 10^{-6}(3 \times 10^8 t - z\sqrt{5})]\vec{a}_x$ MV/m; (iv) in a metallic conductor at 50 Hz, if $\varepsilon = \varepsilon_0$, $\mu = \mu_0$, $\sigma = 5.8 \times 10^7$ S/m, and $\vec{J} = \sin(314t - 117.1z)\vec{a}_x$ MA/m^2. 10

b) A plane wave travelling in the +y direction in a lossy medium ($\varepsilon_r = 4$, $\mu_r = 1$ and $\sigma = 10^{-2}$ S/m) has $\vec{E} = 0.9 \cos(10^9 \pi t + \pi/4)]\vec{a}_z$ V/m at $y = 0$. Find 12

(i) $\vec{E}$ at $y = 1$ m, $t = 2$ ns.
(ii) The distance travelled by the wave to have a phase shift of 10°.
(iii) The distance travelled by the wave to have its amplitude reduced to 40%.
(iv) $\vec{H}$ at $y = 2$ m, $t = 2$ ns.

c) What is meant by vector magnetic potential? 3

8 a) The plane wave $\vec{E} = 50\sin(\omega t - 5x)\vec{a}_y$ V/m in a lossless medium ($\mu = 4\mu_0$ and $\varepsilon = \varepsilon_0$) encounters a lossy medium ($\mu = \mu_0, \varepsilon = 4\varepsilon_0$ and $\sigma = 0.1$ S/m) normal to the x axis at $x = 0$. Find (i) reflection coefficient, (ii) transmission coefficient, (iii) standing wave ratio and (iv) transmitted electric and magnetic fields. 12

b) What is meant by Brewster angle? 3

c) Enumerate the general steps for finding the radiation fields of a Hertzian antenna. A 2.0A source operating at 300 MHz feeds a Hertzian dipole of length 5 mm situated at the origin. Find electric field, magnetic field, radiation resistance and radiation power at (10 m, 30°, 90°). 10

B.Sc. Engg.(EE)/HDEE, 5th Sem. 160 Date: May 17, 2019 (Morning)

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

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A.Y. 2018-2019
Course No.: EEE 4503/EEE 4591 — Time: 3 Hours
Course Title: Power Electronics — 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. Symbols carry their usual meanings. Assume reasonable value for any missing data.

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1. a) For handling high power conversion, engineers always prefer to use power electronic systems. Why do they prefer power electronics over linear electronics? 08

   b) After applying a reverse bias, the slope of the falling current of a semiconductor power diode has been calculated as 50 A/μs. The current changes its slope from positive to negative after 2μs from the zero crossing. The total charge accumulated during the reverse recovery process is 150 μC. Calculate the peak reverse current and softness factor. Can you use the approximation formula to solve this problem? Why? 08

   c) Propose a simple diode circuit with passive elements that provides under-damped current so that a thyristor can be turned off forcefully. The dc source voltage of the circuit is 220 V. Design the circuit for a damping factor of 45000 ohm/henry. Take resonant frequency as 10^6 rad/s and capacitance as 0.05μF. Find the equation of the decaying current with initial conditions of $v_c(t = 0) = 0$ and $i(t = 0) = 0$. 09

2. a) The wave-shape of the load current of an uncontrolled ac to dc converter is shown in Fig. 2(a). (i) What type of load is connected to this converter? (ii) Draw the wave- shape of the input current for full wave conversion. (iii) Calculate the average value of the load current. (iv) Ignoring the ripple value of the input current, calculate the THD and input power factor of the converter. 10

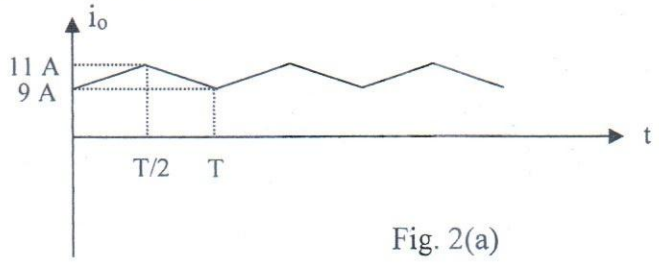

Fig. 2(a)

   b) Following is a diode circuit in Fig. 2(b), whose input voltage is $v_s = 381\sin 314t$, and the battery voltage is E = 100 V. The current stops conducting at $\beta = 215°$. Draw the wave-shape of the output voltage and also, calculate the average value of the output voltage. 10

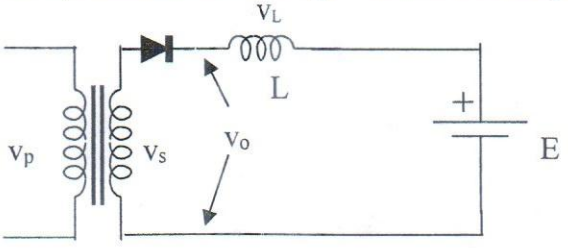

Fig. 2(b)

c) A half wave rectifier of a constant load current I_A = 20 A with a source inductance, L_S = 5 mH is shown in Fig. 2(c). The input voltage is $V_s = 325\sin\omega t$ where f = 50 Hz. Calculate the commutation angle and the average value of the output voltage. 05

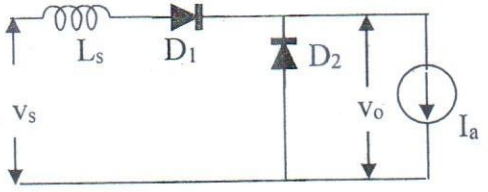

Fig. 2(c)

3. a) For the following converter circuit in Fig. 3(a), T_1 is fired at $\omega t = 30^\circ$ and T_2 is fired at $\omega t = 210^\circ$. Draw the output voltage and input current wave-shapes and find the expression of the average output voltage. If a free-wheeling diode is connected across the load, will there be any change in the output voltage? 10

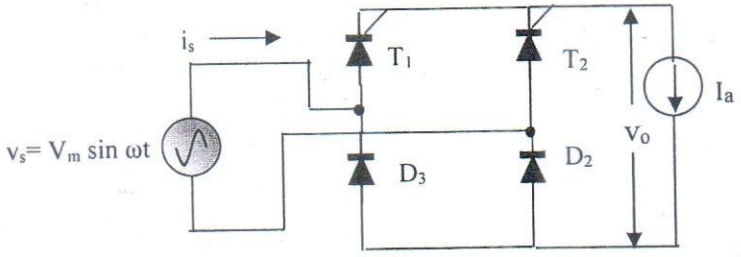

Fig. 3(a)

b) For the following rectifier in Fig. 3(b), L_S = 1 mH and the input is sinusoidal with the rms value of 120 V at 60 Hz. The battery voltage is 150 V. Assuming discontinuous load current i_d, find the value of angles at the beginning of conduction and ceasing of conduction. Also, calculate the average value of the current. 15

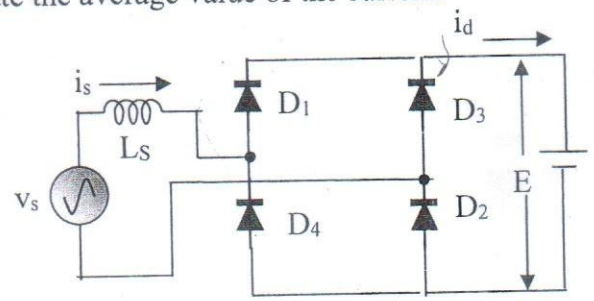

Fig. 3(b)

4. a) Draw the circuit diagram of a three phase diode bridge rectifier. Draw the wave shapes of output voltage, line current and diode current of any phase. Find the expressions of V_{dc}, rms diode current and transformer secondary current. 12

b) Draw the circuit diagram of a single phase controlled rectifier with a source inductance supplying a highly inductive load. The source inductance, L_S is 5% with the rated voltage of 230 V at 60 Hz and the rated volt-amperes of 5 kVA. Calculate the commutation angle and output voltage for an output power of 3 kW. The thyristors are fired at 30° and 210°, respectively. 13

5. a) Suppose, you have only one SCR and several diodes available with you. Propose an ac controller that provides you bidirectional ac controlled output. If the load is purely resistive of 10 ohm resistance, design the circuit for an input voltage, V_s = 120 V (rms), f = 50 Hz. 10

b) A single-phase full-wave ac controller with an RL load is supplied with an rms voltage, $V_S = 120$ V, f = 60 Hz. The load inductance, L = 6.5 mH. The thyristors are fired at $\alpha_1 = 60^0$ and $\alpha_2 = \pi+60^o$, respectively. The thyristor 1 ceases conduction at $\beta = 240^0$. (i) What will be the value of load resistance? (ii) For this load, if α_1 is made less than 60^0, what will be the output voltage of the controller? 10

c) Mention three applications of ac controller. What is the disadvantage of a unidirectional ac controller? 05

6. a) For a step down dc-dc converter having RL load, if the load current is contiuous, derive the expression of maximum ripple current. 09

b) Draw the circuit diagram of a step down dc to dc converter with an RL load. Suppose, the converter is operating in the discontnuous mode. Find the expression of the time interval of the converter after the switch is turned off. 07

c) A step-down converter is feeding an RL load with $V_S = 220$ V, R = 5 Ohm and L = 7.5 mH, f = 1 kHz, k = 0.5. Calculate: (i) the minimum and maximum values of instantaneous load current, (ii) maximum peak to peak load ripple current and (iii) the average value of the load current. 09

7. a) Draw the circuit diagram of a buck-boost regulator. Drawing the waveshapes of various branch currents clearly, identify which current accounts for the ripple of the output voltage. Derive the expression of the ripple voltage at the output. 10

b) A buck-boost regulator has an input voltage $V_S = 12$ V. The duty cycle is k = 0.6. and the switching frequency is 25 kHz. For the inductance, L = 250 μH, filter capacitance, C = 220 μF and for average value of load current, $I_a = 1.5$ A, determine: (i) average output voltage, (ii) the peak to peak output ripple voltage, (iii) the peak to peak ripple inductor current, (iv) expression of transistor peak current and (v) critical value of L and C. 15

8. a) (i) Although the utility power is ac, why do you use an inverter to get an ac voltage? 05
(ii) What are the main differences between an IPS and UPS?

b) Draw the circuit diagram of a single-phase full-bridge inverter. Draw the wave-shapes of output voltage and current for an inductive load. Show the swiching states in a table of the above inverter to obtain an ac voltage. 11

c) A single phase half bridge inverter is supplying a resistive load of 24 Ω and its input is taken from a uncontrolled bridge rectifier where a transformer has been used whose secondary voltage is 53.5 V (rms). Determine: (i) the rms output voltage at the fundamental frequency V_{o1}, (ii) the output power P_o, (iii) the average and peak currents of each transistor and (iv) the THD. 09

B.Sc. Engg. (EE)/HDEE, 5th Sem. Date: May 23, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: Math 4521
Course Title: Numerical Methods

Winter Semester, A. Y. 2018-2019
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) Derive: 10
   i. Secant method using similar triangle approach, and
   ii. Newton-Raphson method from the Taylor series expansion of single variable.

   b) Three-phase loads are common in AC systems. When the system is balanced, the analysis can be simplified to a single equivalent circuit model. However, when it is unbalanced, the only practical solution involves the solution of simultaneous linear equations. In one model, the following equations need to be solved. 15

$$\begin{bmatrix} 3 & -0.1 & -0.2 \\ 0.1 & 7 & -0.3 \\ 0.3 & -0.2 & 10 \end{bmatrix} \begin{bmatrix} I_A \\ I_B \\ I_C \end{bmatrix} = \begin{bmatrix} 7.85 \\ -19.3 \\ 71.4 \end{bmatrix}.$$

   Find the values of I_A, I_B and I_C using the Gauss-Seidel method. Use the following values as initial guess and conduct three iterations. Calculate the absolute relative approximate error after each iteration.

$$\begin{bmatrix} I_A \\ I_B \\ I_C \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}.$$

2. Table 2.1, represents six current versus voltage data, which were obtained from a small signal diode model experiment. 10+15 =25

Table 2.1: Current versus voltage for a small signal diode model

V (volts)	I (amps)
0.6	0.01
0.7	0.05
0.8	0.20
0.9	0.70
1.0	2.00
1.1	4.00

The experimental data can be regressed to, $I = B_3V^3 + B_2V^2 + B_1V + B_0$.

   i. Derive the co-efficient matrix for the unknown B_3, B_2, B_1, and, B_0 using polynomial regression of third order, and
   ii. Solve the derived co-efficient matrix using LU decomposition.

3. Derive: 7+8+ 10=25
   i. n-segment Simpson's 1/3 rule.
   ii. Richardson's extrapolation for n-segment Trapezoidal rule.
   iii. Two point Gauss-quadrature formula.

4. Thermistors are based on materials' change in resistance with temperature. To measure temperature, manufacturers provide a temperature versus resistance calibration curve. If you measure resistance, you can find the temperature. A manufacturer of thermistors makes several observations with a thermistor, which are given in Table 3.1. 12+13 =25

Table 4.1: Temperature as a function of resistance.

R (ohm)	T (°C)
1101.0	25.113
911.3	30.131
636.0	40.120
451.1	50.128

Determine the temperature corresponding to 754.8 ohms using the following:

i. A third order Lagrange interpolation polynomial.
ii. Newton's divided difference method of interpolation and a second order polynomial.

5. Human vision has the remarkable ability to infer 3D shapes from 2D images. The intriguing question is: can we replicate some of these abilities on a computer? Yes, it can be done and to do this, integration of vector fields is required. The following integral needs to perform. 25

$$I = \int_0^{0.8} f(x)dx$$

Where, $f(x) = 0.2 + 25x - 200x^2 + 675x^3 - 900x^4 + 400x^5$.

Use Romberg's rule to find the value of the integral of $O(h^8)$. [Hints: Use Trapezoidal rule of single and multiple segment to calculate $O(h^2)$].

6. a) Derive the forward, backward and central finite-divided difference formulae for the first derivative by taking the second derivative into the account for higher accuracy and mention their order of accuracy. 18

b) Derive central finite-divided difference formula for the second derivative. 7

7. a) Define general expressions for Runge-Kutta second-order method. Derive these expressions from Taylor series expansion about a point. 3+10 =13

b) From general expressions for Runge-Kutta second-order method, derive (i) Heun's Method, (ii) Ralston's Method and (iii) Mid-point Method. 3×4 =12

8. The free-fall portion of a bungee jump system consists of the following ordinary differential equations, which are accounted for solving velocity (v) and position (x) for a bungee jumper. 5+20 =25

$$\frac{dx}{dt} = -0.5x$$

$$\frac{dv}{dt} = 4 - 0.3v - 0.1x$$

Assume that at $t = 0$, $x = 4$ and $v = 6$. Integrate to $t = 1$ from $t = 0$ using a step size of 0.5 by using:

i. Euler method
ii. Fourth order Runge-Kutta method.

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

Date: May 15, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester-Final Examination
Course No.: EEE 4523 / EEE 4595
Course Title: Switchgear and Control Equipment I

Winter Semester, A. Y. 2018-2019
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. Symbols preserve their usual meanings.

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1. a) What do you mean protective zones and dead zones? Draw the figure of a typical power system mentioning protective zones for each component. Can dead zone be practically available in a typical power system? 9

   b) Derive the current equation for sudden short circuit in R-L series circuit. Explain the conditions for D.C. component to become maximum and minimum respectively. 16

2. a) What do you mean by rate of rise of transient recovery voltage (TRV)? What are the significant characteristics of TRV? Explain the effects of natural frequency and power factor on TRV with proper diagram. Derive the equation: R. R. R. $V_{max} = 2\pi E_m f_n$, where E_m and f_n have their usual meaning. 15

   b) A 50 cycle alternating voltage is applied to an R-L series circuit by closing a switch. The resistance is 10 Ω and inductance is 0.1 H. The R.M.S value of applied voltage is 100 V. 10
      i) Find the value of D.C. component of current upon closing the switch if instantaneous value of voltage is 50 V at that time.
      ii) What value of instantaneous voltage will produce a maximum D.C. component of current upon closing the switch?
      iii) What is the instantaneous value of voltage which will result in the absence of any D.C. component upon closing the switch?

3. a) Explain Slepian's theory of arc interruption. What are the drawbacks of this theory? State the assumptions of Cassie's theory and explain how it described arc interruption successfully. 8

   b) Explain interruption of capacitive current for a circuit breaker with proper waveforms. 7

   c) Explain the construction and working principle of Air-Break Circuit Breaker. 10

4. a) Draw and explain the operating principle of the protection circuit for induction motor. How can you give protection to an induction motor against single phasing and ground fault? Explain with proper diagram. 15

   b) Explain the working principle of Minimum Oil Break Circuit Breaker. 10

5. a) Write the physical and dielectric properties of SF_6 circuit breaker. Explain the operation of single pressure puffer type SF_6 circuit breaker. 13

   b) Explain Gas insulated substation (GIS) with its merits and demerits. Draw the section view of a GIS and explain the general constructional features of SF_6 GIS. 12

6. a) Explain restricted earth fault protection of generator. How 100% protection can be given to a generator against earth fault? 10

   b) Draw Merz Price protection of delta connected alternator and explain the necessity of auxiliary relay in this type of arrangement. 8

   c) A generator is protected by restricted earth fault protection. The generator ratings are 13.2 kV, 10 MVA. The percentage of winding protected against phase to ground fault is 70%. The relay setting is such that it trips for 20% out of balance. Calculate the resistance to be added in neutral to ground connection. 7

7. a) Explain negative phase sequence relay with proper schematic diagram. Explain zero sequence currents and negative sequence currents for this type of relay with proper vector diagram. 15

   b) A 500 kVA star connected alternator has a synchronous reactance of 1.0 Ω per phase, full current of 43.74 A and negligible resistance. The differential relay operates if the out of balance current through it exceeds 30% of the normal full load current of the alternator. The star point of the alternator is earthed through a resistance of 5 Ω. What percent of the stator winding is left unprotected? Show that the effect of the alternator reactance can be neglected. 10

8. a) What type of protection provide by Buchholz relay? Draw and explain the construction of Buchholz relay. What are the limitations of this type of relay? 9

   b) A 3 phase power transformer having a line voltage ratio of 400 V to 33 kV is connected in star-delta. The C.T. on 400 V side have current ratio as 1000/5. What must be the C.T. ratio on 33 kV side? Draw the arrangement. Assume current on 400 V side of transformer to be 1000 A. 8

   c) What are the important points that must be taken into consideration for using percentage differential protection for transformers? Explain the frame leakage protection of transformer. 8

B.Sc. Engg. (EE)/ HDEE, 5th Sem. Date: May 28, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A.Y. 2018-2019
Course No.: EEE 4531 — Time: 3 hours
Course Title: Energy Conversion III — 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. Symbols preserve their usual meaning.

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1. a) What are the states of energy? Mention two non-conventional energy sources that would be best suited for Bangladesh and discuss the reasons briefly. 7

   b) What is co-efficient of coupling? Show that the co-efficient of coupling is the geometric mean of coupling factors k_1 and k_2. Explain the concept of duality in an electromagnetic system. 8

   c) What do you understand by "energy in a multiply excited magnetic system"? Describe the concept by developing necessary equations. Define self and mutual inductance and show that $\begin{bmatrix}\lambda_1\\ \lambda_2\end{bmatrix} = \begin{bmatrix}L_{11} & L_{12}\\ L_{21} & L_{22}\end{bmatrix} \times \begin{bmatrix}i_1\\ i_2\end{bmatrix}$ for two coupled coils. 10

2. a) What are Rankine Cycle and Brayton Cycle? Why is an air-gap used in electromagnetic circuits? What would be the effect on the circuit if the air-gap is varied? Explain briefly. 7

   b) Write down the assumptions of an ideal transformer. Show that the ideal transformer transforms voltages in the direct ratio of turns, currents in the inverse ratio and impedances in the direct ratio squared. 8

   c) A single phase transformer has 500 turns on primary and 40 turns on secondary winding. The mean length of the magnetic path in the iron core is 150 cm and the joints are equivalent to an air-gap of 0.1 mm. When 3000 V is applied to primary, maximum flux density is 1.2 Wb/m^2. Calculate (i) the cross-sectional area of the core (ii) no-load secondary voltage (iii) no-load current drawn by primary (iv) power factor on no-load. Given that, AT/cm for a flux density of 1.2 Wb/m^2 in iron to be 5, the corresponding iron loss to be 2 W/kg at 50 Hz and density of iron as 7.8 gm/cm^3. 10

3. a) Differentiate among solar cell, solar module and solar array. What is EVA film? Discuss all the properties of EVA film. 7

   b) What is solar cell? Draw the structure of a solar cell and briefly describe all the parts of it. How much power will be generated if the solar cell is 14% efficient, the size is 14 cm×14 cm and solar radiation is 800 W/m^2 ? 8

   c) Draw the solar cell I-V curve and briefly explain all of the terms. Define fill factor and efficiency of a solar cell. A house owner decides to use a solar PV system to run 5 CFLs (30 watt each) and 4 fans (60 watt each) for 9 hours per day. Sunshine is available 7 hours/day. Peak power rating of PV panel is 45 W, operating factor is 0.70 and the efficiency 10

of inverter and battery are 0.85 and 0.88, respectively. Battery voltage and depth of discharge are 10 V and 0.80, respectively. What is the total load? Find out the number of PV panels, batteries and inverters required for the system. What will be the total cost of the system if the unit prices of the solar modules, batteries and inverters are 10000 Tk, 8000 Tk and 6000 Tk respectively?

4. a) Differentiate between average speed and schedule speed. Show that, for a trapezoidal system crest speed, $V_m = \frac{t - \sqrt{t^2 - 4kD}}{2k}$. Find out the expression for 'k' for this system. 7

   b) A 25 kW, 250 V DC shunt generator has armature and field resistance of 0.06 Ω and 200 Ω respectively. Determine the total armature power developed when working as a motor taking 25 kW input. 8

   c) A train runs between 2 stations which are 1500 m apart. Crest speed is 1.25 times of the average speed. Acceleration and retardation are 1.8 and 3.6 km/h/s respectively and stop time is 21 seconds. Find out schedule speed by assuming trapezoidal system. 10

5. a) What is back emf in a DC motor? A 460 V series motor runs at 500 r.p.m, taking a current of 40 A under rated condition. Calculate the speed and percentage change in torque if the load is reduced so that the motor is taking 30 A. Total resistance of the armature and field circuits is 0.8 Ω. Assume flux is proportional to the field current. 7

   b) An industry wants to install wind turbine to generate actual energy of 30000 kWh. Wind speed is 6 m/s at height 20 m from ground. Which turbine do you suggest? Make necessary assumptions and estimate rotor size and power rating of the turbine. 8

   c) For a wind power system, define coefficient of performance, capacity factor, tip speed ratio, lift force and horizontal axis wind turbine. 10

6. a) Discuss different types of absorbers. Draw the schematic diagram of heat transfer type solar cooker and explain briefly. Mention its advantages and disadvantages. 7

   b) Discuss the basic block diagram of solar thermal energy system. Draw the schematic diagram of solar water heater and explain its working principle. 8

   c) What is payback period? Suppose a 1 LPG cylinder has 13.5 kg fuel, caloric value of LPG is 12.6 kWh/kg and 70% of the total energy of LPG can be used. Price of 1 LPG cylinder and 1 box type solar cooker are 400 Tk and 2000 Tk respectively. The box cooker cooks 2 meals for 3 persons with an efficiency of 40%. Heat required to cook for 1 person is 900 KJ. Calculate the payback period for box type solar cooker. 10

7. a) What is the difference between solar PV system and solar thermal system? Draw the schematic diagram of a single basin solar still and explain briefly solar distillation system. 7

   b) A 4-pole, 3 phase induction motor operates from a supply of 50 Hz frequency. Calculate: 8

      (i) Speed at which magnetic field of the stator is rotating.
      (ii) Speed of rotor when slip is 0.04.
      (iii) Frequency of rotor currents when slip is 0.03.
      (iv) Frequency of rotor currents at standstill.

c) Design a PV system for pumping 50000 litres of water from a depth of 20 meter where drawdown is 5 m, frictional loss is 6% of the total vertical lift, solar PV module's rating is 40 Watt-peak, operating factor is 0.85, pump efficiency is 0.40 and mismatch factor is 0.85. 10

8. a) What is co-energy? Draw the e-q curve of a simple charged capacitor and point out energy and co-energy and write the corresponding integral equations. Show that $W_{fld} = W'_{fld} = \frac{1}{2}Ce^2$ for energy in an electrostatic field. 7

b) The magnetic circuit shown in Fig. 8(b) has dimensions as $A_c = A_g = 10$ cm^2, g = 0.060 cm, $l_c = 40$ cm, N = 600 turns, $\mu_r = 70{,}000$ for core material, $B_c = 0.1$ T. (i) Find the core and air gap reluctances (ii) Determine flux, φ and current, i (iii) Write a MATLAB script where the inductance of the magnetic circuit should be plotted as function of core permeability over the range $100 \leq \mu_r \leq 100000$. 8

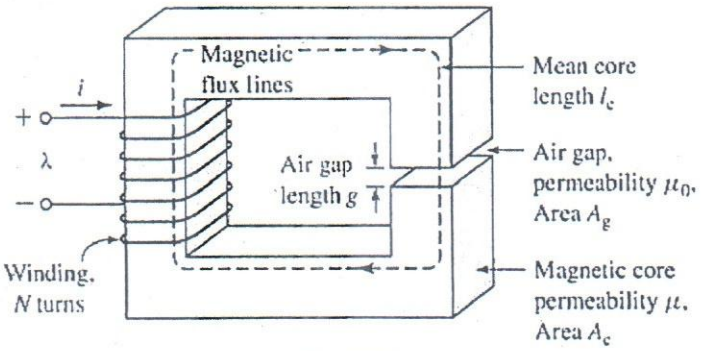

Fig. 8(b)

c) A 220 V shunt motor has an armature resistance of 0.6 Ω and takes an armature current of 40 A on a certain load. How much the main flux must be reduced to raise the speed by 50% if the developed torque is constant? Neglect saturation and armature reaction. 10

B.Sc.Engg. (EE)/HDEE, 5th Sem. Date: May 15, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 4541 — Time: 3 Hours
Course Title: Wireless Communication — 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) What is the audio information bandwidth or baseband bandwidth for AM and FM radio broadcast in different ITU regions? What is the advantage when a larger bandwidth is chosen in this case? For FM radio broadcast, what is the total operating frequency range and what is the bandwidth of operation for each channel? 9

   b) Consider FM radio broadcast with its standard Intermediate Frequency (IF) for the superheterodyne receiver. If the incoming carrier frequency is 99.2 MHz, what is the frequency of the image signal? 6

   c) What is the ITU Region number for Australia? Which frequencies are going to be used most popularly for 5G cellular communication? 5

   d) Is it true that the penetration loss always increases with frequencies for all types of materials? Comment on the penetration loss of concrete at different frequencies. 5

2. a) Mention the factors, on which, the penetration loss of an obstruction depends. Compare the building penetration loss (BPL) between old and new building types. Give reasons for their differences. 7

   b) What was a common use of sky wave in the past? 3

   c) A transmitter is at height 80 m from the ground and a receiver is at height 30 m from ground. They are 2.5 km away from each other. There is a Knife-Edge Blockage at a distance 1.5 km from the transmitter and the blockage is 65 m higher than the transmitter. The transmitter is transmitting at power 30 dBm and the signal frequency is 1.5 GHz. The Gain of the transmitter and the receiver is 10 dB and 2 dB, respectively. Determine the power received. How many Fresnel zones are fully blocked? 10

$$[\, G\,(dB) = 20\log\left(0.4 - \sqrt{0.1184 - (0.38 - 0.1\nu)^2}\right) \qquad 1 < \nu < 2.4$$

$$G\,(dB) = 20\log\left(\frac{0.225}{\nu}\right) \qquad \nu > 2.4\,]$$

   d) Explain how diffraction gain, G_d (dB) can take on positive values. 5

3. a) What are the factors that may be considered for a non-LOS link to set the expected maximum BER? What are the factors that may be considered to set the expected minimum Eb/No or CINR? 8

b) Both mobile station (MS) and base station (BS) have the requirements for reception as shown next: noise floor = − 125 dBm; antenna noise figure = 5 dB and Carrier to Noise (C/N) ratio = 15 dB. BS uses these values for both reception and transmission: antenna gain = 15 dB and cable loss = 2 dB. MS uses these values for both for reception and transmission: antenna gain = 0 dB; body loss = 2 dB and vehicle loss = 1 dB. Both MS and BS use 4 dB fade margin for transmission. The maximum transmit power for the MS is 33 dBm. Write down link budget for reception and transmission. Calculate the transmit power for the BS in dBm. Use balanced path. 10

c) The number of permissible MCS levels is growing in the course of time. What is the advantage of this growth? 4

d) What are the names of Licensed Assisted Access (LAA) in Release 13 and Release 14? 3

4. a) Write down the major problem with unlicensed radio bands and how this problem may be addressed. 6

b) Compare the capacities of 2G and 3G cellular communication systems in terms of their approximate number of voice calls using the same bandwidth. Compare the two most efficient coding techniques for cellular communication. 7

c) The received signal power is 200 mW and the total noise power is 2 mW. The operating bandwidth is equal to the total bandwidth of 2.4 GHz ISM band. Determine the theoretical maximum possible data rate with arbitrarily small error probability. What will happen if data is sent at a rate higher than this maximum value? 8

d) Write down the names of the propagation models that can support frequencies up to 100 GHz. 4

5. a) Discuss the factors that you need to consider to determine whether a system would have noise limited links or interference limited links. Which one, between noise and interference limited links, typically, has better signal reception? 8

b) Consider that an LTE user has moved further away from the base station. Explain all possible ways the following parameters are affected and the correlation among these parameters:
CINR, EVM, modulation level, code rate, CQI, transmit power, amount of radio resources allocated, amount of packet retransmissions, and data rate. 10

c) Why is the first stage amplifier of a wireless receiver made with as little noise as possible? What is the name of this amplifier? What is the maximum possible frequency to update the transmit power level in LTE? 7

6. a) What are the names of Machine-Type Communications (MTC) in Release 13, 14 and 15? What are the usual major differences in requirements between supporting M2M communication and H2H communication? How have these requirements been addressed with new UE categories in Release 13 and Release 14? In the early days of LTE, which UE category was used for M2M devices and how many antennas could be used in the M2M device with that UE category? 10

b) What are the advantages and disadvantages of long discontinuous reception (DRX) cycle? Briefly explain how extended discontinuous reception (eDRX) and power saving mode (PSM) save power. How long can be the maximum sleep time for eDRX and PSM? 10

c) Compare Sigfox and NB-IoT in terms of current and future share in the market. 5

7. a) Write down the reasons for the possibility of a GPS receiver to fail to decode the signal from the GPS satellite. When was the first next-generation GPS satellite launched? How many operational GPS satellites are currently flying? 7

b) Compare GEO satellite phones and LEO satellite phones in terms of their advantages and disadvantages. For a new project that wants to cover the whole Earth using satellites, what are the advantages and disadvantages, if a low height is chosen for the satellites? 8

c) A satellite is located 4000 km above the sea level. What is its type of orbit? 4

d) Write down the name of the satellite phone operators, which are currently providing commercial services. Compare these operators in terms of their coverage on the Earth. Why does Bangladesh Government have restrictions on the use of satellite phone? 6

8. a) For Rayleigh fading model, derive the relationship between the amplitude of the received signal and in-phase and quadrature components of Gaussian random variables. 10

b) Explain what is actually meant by outage probability of wireless coverage at a particular distance. Is it logical to consider thermal noise power as Additive White Gaussian Noise (AWGN)? 6

c) The salaries of employees in a company are normally distributed with a mean of Tk. 50,000 and a standard deviation of Tk. 20,000. Determine what percent of people earn less than Tk. 40,000. Determine what percent of people earn between Tk. 45,000 and Tk. 65,000. 9

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.9	.00005	.00005	.00004	.00004	.00004	.00004	.00004	.00004	.00003	.00003
-3.8	.00007	.00007	.00007	.00006	.00006	.00006	.00006	.00005	.00005	.00005
-3.7	.00011	.00010	.00010	.00010	.00009	.00009	.00008	.00008	.00008	.00008
-3.6	.00016	.00015	.00015	.00014	.00014	.00013	.00013	.00012	.00012	.00011
-3.5	.00023	.00022	.00022	.00021	.00020	.00019	.00019	.00018	.00017	.00017
-3.4	.00034	.00032	.00031	.00030	.00029	.00028	.00027	.00026	.00025	.00024
-3.3	.00048	.00047	.00045	.00043	.00042	.00040	.00039	.00038	.00036	.00035
-3.2	.00069	.00066	.00064	.00062	.00060	.00058	.00056	.00054	.00052	.00050
-3.1	.00097	.00094	.00090	.00087	.00084	.00082	.00079	.00076	.00074	.00071
-3.0	.00135	.00131	.00126	.00122	.00118	.00114	.00111	.00107	.00104	.00100
-2.9	.00187	.00181	.00175	.00169	.00164	.00159	.00154	.00149	.00144	.00139
-2.8	.00256	.00248	.00240	.00233	.00226	.00219	.00212	.00205	.00199	.00193
-2.7	.00347	.00336	.00326	.00317	.00307	.00298	.00289	.00280	.00272	.00264
-2.6	.00466	.00453	.00440	.00427	.00415	.00402	.00391	.00379	.00368	.00357
-2.5	.00621	.00604	.00587	.00570	.00554	.00539	.00523	.00508	.00494	.00480
-2.4	.00820	.00798	.00776	.00755	.00734	.00714	.00695	.00676	.00657	.00639
-2.3	.01072	.01044	.01017	.00990	.00964	.00939	.00914	.00889	.00866	.00842
-2.2	.01390	.01355	.01321	.01287	.01255	.01222	.01191	.01160	.01130	.01101
-2.1	.01786	.01743	.01700	.01659	.01618	.01578	.01539	.01500	.01463	.01426
-2.0	.02275	.02222	.02169	.02118	.02068	.02018	.01970	.01923	.01876	.01831
-1.9	.02872	.02807	.02743	.02680	.02619	.02559	.02500	.02442	.02385	.02330
-1.8	.03593	.03515	.03438	.03362	.03288	.03216	.03144	.03074	.03005	.02938
-1.7	.04457	.04363	.04272	.04182	.04093	.04006	.03920	.03836	.03754	.03673
-1.6	.05480	.05370	.05262	.05155	.05050	.04947	.04846	.04746	.04648	.04551
-1.5	.06681	.06552	.06426	.06301	.06178	.06057	.05938	.05821	.05705	.05592
-1.4	.08076	.07927	.07780	.07636	.07493	.07353	.07215	.07078	.06944	.06811
-1.3	.09680	.09510	.09342	.09176	.09012	.08851	.08691	.08534	.08379	.08226
-1.2	.11507	.11314	.11123	.10935	.10749	.10565	.10383	.10204	.10027	.09853
-1.1	.13567	.13350	.13136	.12924	.12714	.12507	.12302	.12100	.11900	.11702
-1.0	.15866	.15625	.15386	.15151	.14917	.14686	.14457	.14231	.14007	.13786
-0.9	.18406	.18141	.17879	.17619	.17361	.17106	.16853	.16602	.16354	.16109
-0.8	.21186	.20897	.20611	.20327	.20045	.19766	.19489	.19215	.18943	.18673
-0.7	.24196	.23885	.23576	.23270	.22965	.22663	.22363	.22065	.21770	.21476
-0.6	.27425	.27093	.26763	.26435	.26109	.25785	.25463	.25143	.24825	.24510
-0.5	.30854	.30503	.30153	.29806	.29460	.29116	.28774	.28434	.28096	.27760
-0.4	.34458	.34090	.33724	.33360	.32997	.32636	.32276	.31918	.31561	.31207
-0.3	.38209	.37828	.37448	.37070	.36693	.36317	.35942	.35569	.35197	.34827
-0.2	.42074	.41683	.41294	.40905	.40517	.40129	.39743	.39358	.38974	.38591
-0.1	.46017	.45620	.45224	.44828	.44433	.44038	.43644	.43251	.42858	.42465
-0.0	.50000	.49601	.49202	.48803	.48405	.48006	.47608	.47210	.46812	.46414

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
0.1	.53983	.54380	.54776	.55172	.55567	.55962	.56356	.56749	.57142	.57535
0.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
0.3	.61791	.62172	.62552	.62930	.63307	.63683	.64058	.64431	.64803	.65173
0.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
0.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
0.6	.72575	.72907	.73237	.73565	.73891	.74215	.74537	.74857	.75175	.75490
0.7	.75804	.76115	.76424	.76730	.77035	.77337	.77637	.77935	.78230	.78524
0.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
0.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97778	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997

B.Sc. Engg.(EE) / HDEE, 5th Sem. Date: 28 May 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 4551 — Time: 3 Hours
Course Title: Data Communication and Networking 1 — 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. Symbols preserve their usual meanings.

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1. a) "Network has made telecommuting available to individuals". How networks impact our daily lives? Explain with suitable example. 4

   b) What is Ethernet? What is the transmission rate of Ethernet LANs? 4

   c) What is Throughput in networking? Why is it important for data transfer? How does bottle-neck occur if throughput is not considered perfectly? 10

   Suppose EEE-16 Sec-A at room 201 wants to send a large file of Energy-Data-Logger to EEE-16 Sec-B at room 202. The path from Sec-A at room 201 to Sec-B at room 202 has three links, of rates $R_1 = 3$ Mbps, $R_2 = 7$ Mbps, and $R_3 = 500$ kbps.
   i) Assuming no other traffic in the network, what is the throughput for the file transfer?
   ii) Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Sec-B at room 202?
   iii) Repeat (i) and (ii), but now with R_2 reduced to 100 kbps.

   d) Explain Ring Topology, Star Topology, and Bus Topology. Discuss the advantages and disadvantages of these three topologies. For the Internet connectivity which topology is suitable, justify your answer with suitable illustrations. 7

2. a) As a Network Engineer, to build a real-world sustainable practical product, you need to follow five steps. 15

   Step1: Finding a problem and define the expected solution and hypothesis,
   Step2: Create a Mathematical Model,
   Step3: Create Simulation Model,
   Step4: Create Practical Product.
   Step5: Socio-economic impact for your product.

   Briefly explain each step and following those, design a network for an educational institution like IUT to provide students and faculty members with access to online information. Use suitable illustrations.

   b) You are asked to create networks between computer devices by choosing from the five different network topologies classified by Area Network (AN). Write those five categories. Briefly explain each of them with suitable diagrams. 10

3. a) As a network designer, why do you need a protocol suite? What does happen among network components if there is no protocol suite? Why are standards important for protocols? 4

   b) Networks are complex, with many "pieces" such as hosts, routers, links of various media, applications, hardware, software, etc. To deal with these complex systems a layering based protocol standard called Open Systems Interconnection (OSI) model is widely used. Write the name of layers of the OSI model. Briefly explain the responsible job done by each layer and how do they contribute to the whole network. Use suitable illustrations. 13

   c) Consider a packet of length L which begins at end system A and travels over three links to a destination end system B. These three links are connected by two packet switches. Let d_i, s_i, and R_i denote the length, propagation speed, and the transmission rate of link i, respectively (i = 1, 2, 3). The packet switch delays each packet by d_{proc}. Assuming no queuing delays, in terms of d_i, s_i, R_i, (i = 1,2,3), and L, what is the total end-to-end delay for the packet? 8
   Suppose now the packet is 1,500 bytes, the propagation speed on all three links is same, i.e., 2.5×10^8 m/s, the transmission rate of all three links is same, i.e., 2 Mbps, the packet switch processing delay is 3 msec, the length of the first link is 5,000 km, the length of the second link is 4,000 km, and the length of the last link is 1,000 km. For these values, what is the end-to-end delay?

4. a) What are the five layers in the Internet protocol stack (TCP/IP model)? What are the principal responsibilities of each of these layers? Use suitable illustrations. 7

   b) What are protocol data unit (PDU), Header, Trailer in data encapsulation in TCP/IP? 6

   Briefly, explain - i) an application-layer message, ii) a transport-layer segment, iii) a network layer datagram, iv) a link-layer frame. Use suitable illustrations.

   c) Which layers in the Internet protocol stack does a router process? Which layer does a link-layer switch process. Which layer does a host process? Why is the Transport layer called the heart of the OSI model? Justify each answer with suitable illustrations. 6

   d) What do you understand by Transmission Control Protocol (TCP), and User Datagram Protocol (UDP)? 6
   What do you understand by connection-oriented and connectionless services? Is downloading a music file from the Internet connection-oriented or connectionless? Is email connection-oriented or connectionless?

5. a) In the network protocol hierarchies, explain *Services, Interface,* and *Primitives.* 6

   b) In network protocol layers, explain *Entities, Peer-entities, Service-provider, Service-user, Service-access-points.* 8

   c) For services between layers, explain how do *Request, Indicate, Response* and *Confirm* occur? Use suitable illustrations. 7

   d) What is Bandwidth? What is analog bandwidth and digital bandwidth? Is 100MHz = 100Mbps? Briefly explain. 4

6. a) As a network engineer, to create a computer network, you are asked to select between circuit switching and packet switching; what do you choose? Justify your answer using suitable illustrations. Mention the advantage and disadvantage of circuit switching and packet switching. 13

b) Consider the circuit-switched network in the following Figure 6(b). There are 4 circuits on each link. The four switches A, B, C and D, going in the clockwise direction. 12

i) What is the maximum number of simultaneous connections that can be in progress at any one time in this network?

ii) Suppose that all connections are between switches A and C. What is the maximum number of simultaneous connections that can be in progress?

iii) Suppose you want to make four connections between switches A and C, and another four connections between switches B and D. Can you route these calls through the four links to accommodate all eight connections?

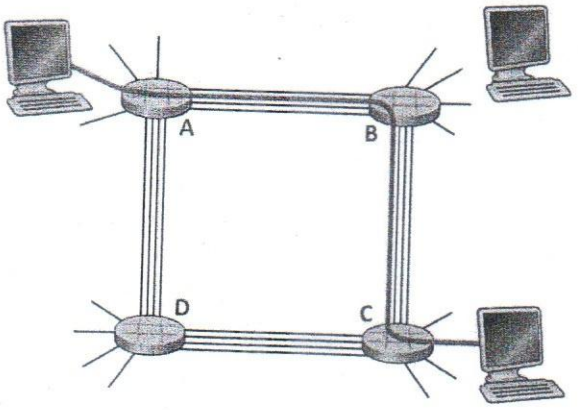

Figure 6 (b).

7. a) To overcome the challenges of designing a packet switch network, briefly answer the followings: 15

i) How should a destination be identified?

ii) How can a sender find the identification of a destination?

iii) How large should a packet be?

iv) How can a network recognize the end of one packet?

v) How can a network recognize the beginning of another packet?

vi) If a network is shared, then how can they coordinate to ensure that each receives a fair opportunity to send?

vii) How can network technologies be designed to meet various requirements for speed, distance, and economic cost?

viii) How can network handle data loss, packet delay, throughput requirement?

b) Consider sending a packet from a source host to a destination host over a fixed route. List the delay components in the end-to-end delay. Which of these delays are constant and which are variable? 6

c) Suppose you would like to urgently deliver 40 terabytes data from IUT to OIC Head-quarter. You have available a 100 Mbps dedicated link for data transfer. Would you prefer to transmit the data via this link or instead use FedEx overnight delivery? Explain. 4

8. a) Explain the Internet of Things (IoT). How does it work? What are the benefits of IoT? 8

b) Explain Internet of Energy (IoE) and Energy Network considering the Internet of Things (IoT), smart grids and Energy Management (Energy Cloud). 9

c) Briefly explain Big Data and Big Data analysis on the Internet of Energy (IoE). Mention and describe 10 Vs of Big data. 8

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B.Sc. TE. (2-Yr), 1st Sem. Date: May 23, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 4597 — Time: 3 Hours
Course Title: Telecommunication Principles — Full Marks: 150

There are **8 (eight)** questions. Answer **any 6 (six)** questions. All questions carry equal marks. Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. All symbols bear their usual meanings. Make reasonable approximation(s) for missing information.

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1. a) Define dynamic range. Explain nonlinear modulation in detail and mention why it is also called a single balanced modulator. 2+10

   b) Why are the single sideband (SSB) modulated outputs known as suppressed carrier signals? How can you improve the spectral efficiency of amplitude modulation? 6

   c) Explain the frequency discrimination method for generation of SSB signal 7

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. 17

   b) Explain the process of frequency mixing. What are meant by up and down conversions? 8

3. a) 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
      I. $x_c(t)$ is a PM signal with $k_p = 5$,
      II. $x_c(t)$ is an FM signal with $k_f = 5\pi$.

   b) Define angle modulation. How is it different from amplitude modulation? 5

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

4. a) What is double sideband suppressed carrier (DSB-SC) modulation? Why is this process also known as coherence detection? 7

   b) Design a DSB-SC modulator for generating a modulated signal $km(t)\cos\omega_c t$; where m(t) is a signal band-limited to B Hz and the carrier generator generates $\cos^3\omega_c t$. Explain how you can generate the desired signal including filter type, signal spectra before and after filtering. Also find whether this scheme will work if the carrier generator produced $\cos^2\omega_c t$ in place of $\cos^3\omega_c t$ and measure the minimum usable value of ω_c. 18

5. a) Define and explain VSB amplitude modulation. State the use of VSB in broadcast television along with its associated problems. How is the bandwidth of the VSB signal higher than that of the SSB signals? 5+6+3

   b) Write the difference between FDM and TDM. Explain T1 time division multiplexing. 3+8

6. a) Using the single-tone modulating signal $\cos\omega_m t$, verify that the output of the SSB generator by phase shifter is indeed an SSB signal, and show that an upper-sideband (USB) or a lower-sideband (LSB) signal results from subtraction or addition at the summation junction. Also demonstrate the coherent demodulation of this SSB signal. 14

   b) Define and explain quadrature amplitude modulation (QAM). 11

7. a) Explain the operation of an envelope detector. Define amplitude modulation index. When is a carrier said to be over-modulated? 8+5

   b) Show mathematically why AM and PM are referred to as linear and non-linear modulation respectively. 12

8. a) Show that the fourier spectrum of an angle modulated signal is not related to the message signal spectrum in any simple way as amplitude modulation. Explain modulation index for angle modulation. 7+5

   b) Explain the indirect method of generation of narrowband angle modulated signal. What are the main advantage and disadvantage in direct method of FM generation? 9+4

B.Sc. Engg.(EE), 7th Sem. Date: May 21, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 4701 — Time: 3 Hours
Course Title: Digital Signal Processing I — 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) Determine the discrete-time signal $v[n]$ obtained by uniformly sampling a continuous-time signal, 13
$v_a(t) = 6\cos(60\pi t) + 3\sin(300\pi t) + 2\cos(340\pi t) + 4\cos(500\pi t) + 10\sin(660\pi t)$,
at a sampling rate of 200 Hz.

   b) Graphically show that for an infinitely long pure sinusoidal signal has only one frequency component according to Fourier Transform. 12

2. a) Determine the convolution sum of an arbitrary input having at least three sample data to the shifted impulse $\delta(n-2)$. Show the steps graphically. 10

   b) Show with example that the Field II structure is efficient than Field I structure. 7

   c) "Up-Sampling is a Time-Variant operation" - justify this statement with an example. 8

3. a) Determine the response $y(n)$, for $n \geq 0$ for the following system: 12
$y(n) - 0.5y(n-1) = (-0.5)^n u(n-1)$, when $y(-1) = 2$.

   b) Using DFT, determine and sketch the magnitude and phase spectra for the following periodic signal: 13
$x(n) = 4sin\frac{\pi(n-2)}{3} + \alpha^n u(n)$.

4. a) Show that a linear convolution can be done by using only circular convolution. 13

   b) Determine $x(n)$ from its Fourier Transform, 12
$X(e^{j\omega}) = j * sin(\omega) * [5 + 6\left(\frac{e^{j\omega}+e^{-j\omega}}{2}\right) + 2\left(\frac{e^{j\omega}+e^{-j\omega}}{2}\right)]$.

5. a) For a seven-point moving average system derive and approximately draw the magnitude and phase responses. 12

   b) Design a very simple low-pass filter using Z-transform. Show the pole and zero locations in the Z-plane. How can you improve the quality of this low-pass filter? Show the positions of the poles and zeros of the improved low-pass filter. 13

6. a) Compute the response of the system, 13

$$y(n) = 0.7y(n-1) - 0.12y(n-2) + x(n-1) + x(n-2)$$

to the input $x(n) = 0.5^n u(n-1)$. Is the system stable?

b) Determine the signal $x(n)$ from its Z-transform, 12

$$X(z) = \frac{3}{1-(10/3)z^{-1}+z^{-2}} .$$

7. Design a second order band-pass filter to pass 2 kHz to 10 kHz signal received from the Mars. The sampling frequency of the system is 50 kHz.

a) Plot the pole and zero of the filter on the Z-plane. 10

b) Plot the approximate magnitude response of $H(e^{jw})$ from Z-plane. 10

c) Find both $H(z)$ and $h(n)$ of the designed filter. 5

8. a) What is the significance of using an all-pass filter? What are the differences between FIR and IIR filter? 13

b) Describe Wavelet-Transform with graphical representation. 12

B. Sc. Engg. (EE), 7th Sem. Date: May 24, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 4703 — Time: 3 Hours
Course Title: Communication Engineering II — Full Marks: 150

There are **8 (eight)** questions. Answer **any 6 (six)** questions. All questions carry equal marks. Marks in the right margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. Assume any data if necessary.

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1. a) Write the properties of autocorrelation of an energy signal and a power signal. Explain the bandwidth of different data in different perspectives. 15

   b) Determine which, if any, of the following functions have the properties of power spectral density functions. Justify your determination. 10
   i) $X(f) = \delta(f) + \cos^2 2\pi f$
   ii) $X(f) = 10 + \delta(f - 10)$
   iii) $X(f) = \exp(-2\pi|f - 10|)$
   iv) $X(f) = \exp[-2\pi(f^2 - 10)]$

2. a) What is correlative coding? Explain Duobinary Coding and Decoding with a demonstration. Also explain precoding with an Illustration. 13

   b) Human speech is characterized by unique statistical properties. How does it affect quantization of signals? 12

3. a) Derive the impulse response of a matched filter that produces the maximum output signal to noise ratio. Explain the correlation realization of a matched filter. Also derive waveform energy. 15

   b) Bipolar pulse signals, $s_i(t)$ $(i = 1, 2)$, of amplitude $\pm 1V$ are received in the presence of AWGN that has a variance of $0.1\ V^2$. Determine the optimum (minimum probability of error) detection threshold, γ_0, for matched filter detection if the a-priori probabilities are: $(i)\ P(s_1) = 0.5$; $(ii)\ P(s_1) = 0.7$; $(iii)\ P(s_1) = 0.2$. (iv) Explain the effect of the a-priori probabilities on the value of γ_0. 10

4. a) Why do BPSK and QPSK manifest the same bit error probability relationship? Explain the demodulator for coherent detection of 16 PSK. 15

   b) Explain bit error probability versus symbol error probability for multiple phase signaling and orthogonal signaling 10

5. a) Explain Binary Differential PSK with an example. Also draw the block diagram of a noncoherent detection of 2 FSK signal. 15

b) A system using matched filter detection of equally likely BPSK signals, $s_1(t) = \sqrt{\frac{2E}{T}} cos w_0 t$ and $s_2(t) = \sqrt{\frac{2E}{T}} cos(w_0 t + \pi)$, operates in AWGN with a received E_b/N_0 of 6.8 dB. Assume that $E\{z(T)\} = \pm\sqrt{E}$. 10

i) Find the minimum probability of bit error, P_B, for this signal set and E_b/N_0.

ii) If the decision threshold is $\gamma = 0.1\sqrt{E}$, find P_B.

6. a) Explain Hamming codes, Extended Golay code and BCH codes. 15

b) Consider a hamming code with m = 3. The generator matrix of this hamming code is given below. 10

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

(i) Find all the codewords of the code.
(ii) Find the parity-check matrix H of the code.
(iii) Compute the syndrome for the received vector 1 1 0 1 1 0 1. Is this a valid code vector?
(iv) What is the error-correcting capability of the code?
(v) What is the error-detecting capability of the code?

7. a) What is a standard array? How can a vector space be represented by a standard array? Describe the process for error correction decoding using a (6, 3) code. Use the parity check matrix $H = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 \end{bmatrix}$. 15

b) Draw and explain the implementation of a (6, 3) decoder using simple circuitry. 10

8. a) Explain the operational procedure for different automatic repeat requests. Explain rectangular code. 15

b) Consider an Extended Golay code capable of double-error corrections. Assume that a non-coherently detected binary orthogonal frequency-shift keying modulation format is used and that the received E_b/N_o = 14 dB. 10

(i) Does the code provide any improvement in probability of message error? If it does, how much? If it does not, explain why not.
(ii) Repeat part (i) with E_b/N_o = 10 dB.

Appendix : 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

B.Sc. Engg. (EE), 7th Sem; May 18, 2019 (Morning)
B.Sc.TE (2Yr), 3rd Sem; B.Sc.TE (1Yr), 1st Sem.

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 4705/EEE 4791 — Time: 3 Hours
Course Title: Control System Engineering — 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. Use suitable assumptions for missing information.

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1. a) Mention three primary objectives of analysis and design of control systems. 3

   b) Find the transfer function, $G(s) = V_O(s)/V(s)$ of the electrical network shown in Fig. 1(b). 10

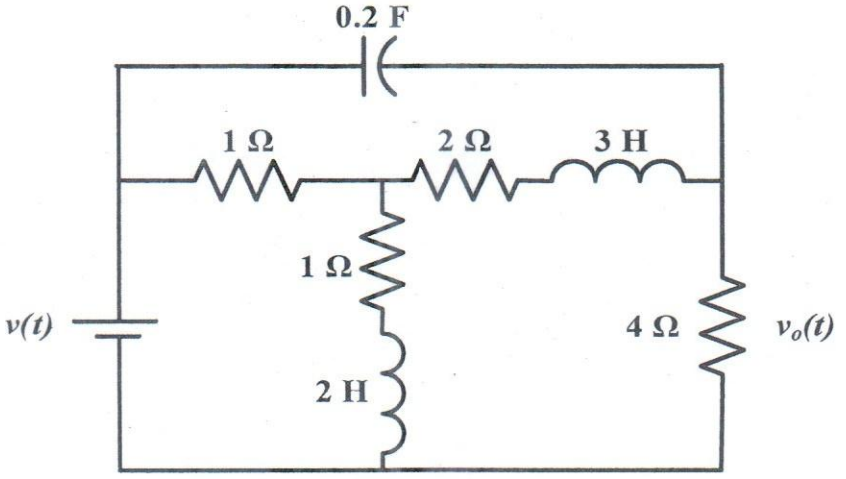

Fig. 1(b)

   c) For the operational amplifier circuit shown in the Fig. 1(c), find the transfer function $G(s) = V_o(s)/V_i(s)$. 12

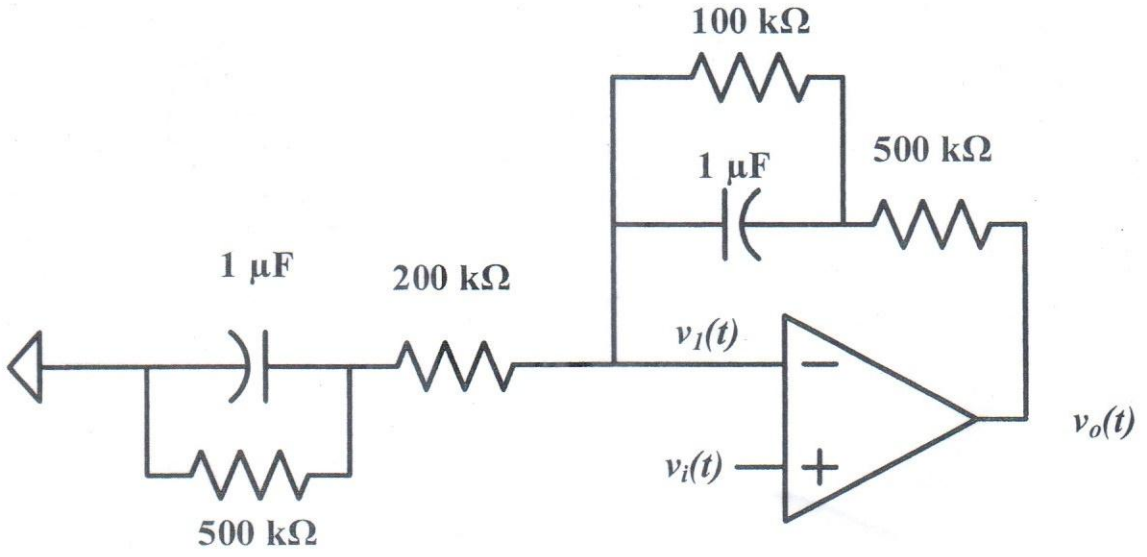

Fig. 1(c)

2. a) Define damping ratio, ζ. How does a 2nd order system behave differently based on its values? 4

   b) Show constant %OS, settling time and peak time lines in s-plane. 3

   c) Consider the translational mechanical system shown in Fig. 2(b). A 1 pound force, *f(t)*, is applied at t = 0. If f_v = 1 N-s/m, find *K* and *M* such that the response is characterized by a 2 s settling time and a 1 s peak time. Also, what is the resulting percentage overshoot? 9

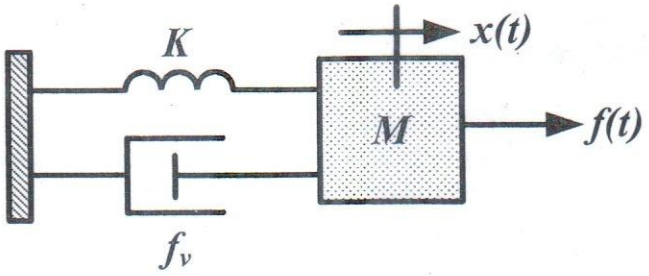

Fig. 2(b)

   d) Determine the value of K and D of the close loop transfer function shown in Fig. 2(c), so that the maximum overshoot in unit-step response is 20% and the peak time is 1 sec. Assume, $J = 5$ kg-m^2. 9

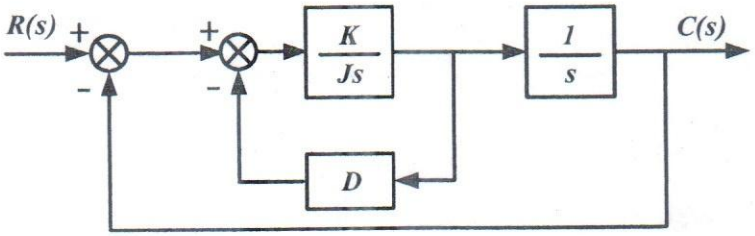

Fig. 2(c)

3. a) Using Mason's rule find the transfer function, $T(s) = C(s)/R(s)$ for the system represented in Fig. 3(a). 10

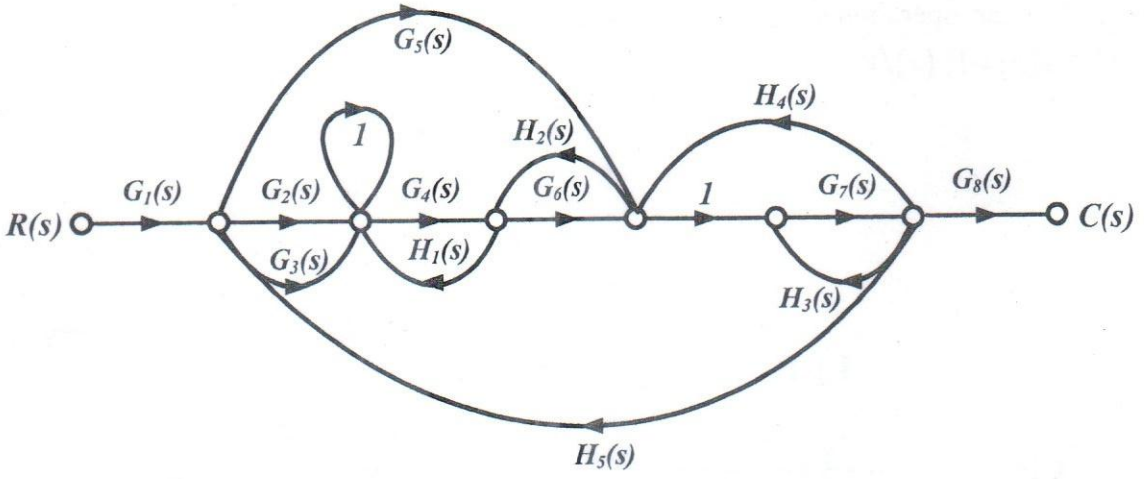

Fig. 3(a)

b) Use block diagram reduction to find the transfer function, $T(s)=C(s)/R(s)$ for the system shown in Fig. 3(b). 10

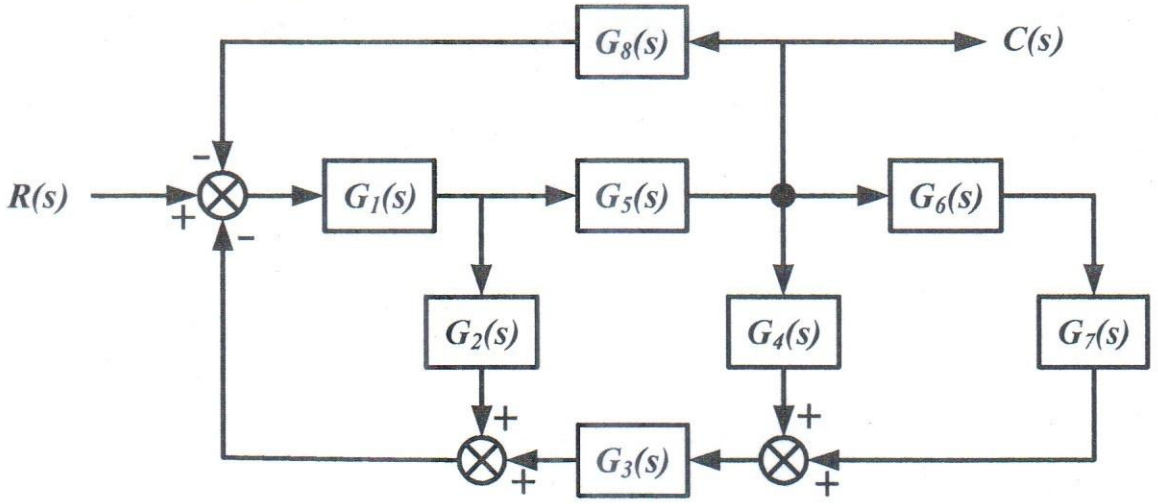

Fig. 3(b)

c) Mathematically explain, how can a PID controller help to meet the system specifications. 5

4. a) Define stability and steady-state error. 2

b) For the system shown in Fig. 4(b), find the value of K that will make the system response oscillatory. Also, find the frequency of oscillation. 11

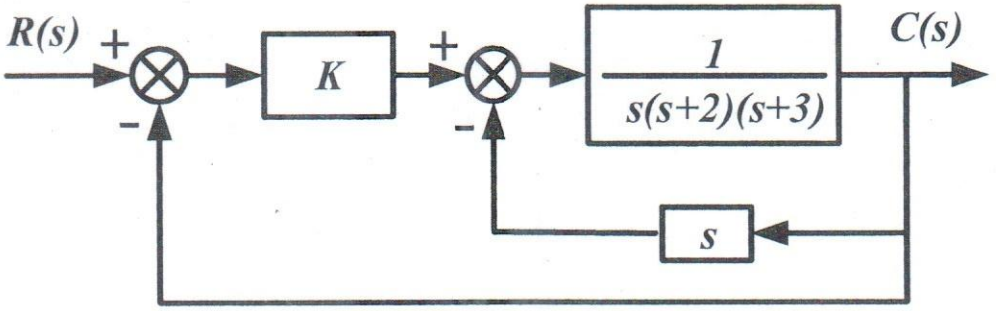

Fig. 4(b)

c) Find the total steady state error due to a unit step input and a unit step disturbance in the system of Fig. 4(c). 12

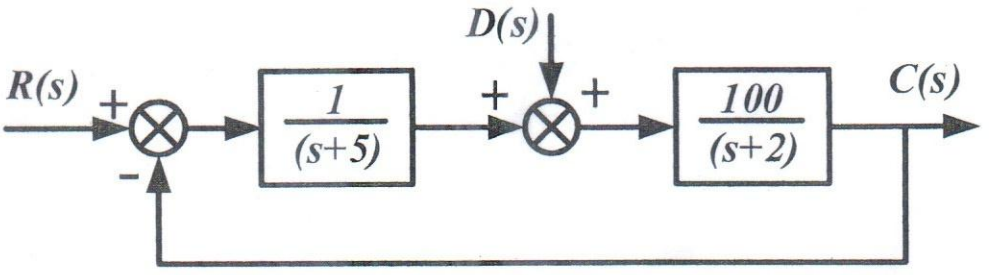

Fig. 4(c)

5. a) For the system shown in Fig. 5(a), find the following: 12

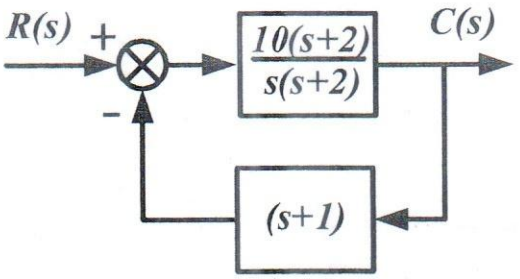

Fig. 5(a)

i. The system type,
ii. The appropriate static error constant,
iii. The input waveform to yield a constant error,
iv. The steady state error for a unit input of the waveshape found in (iii) and
v. The steady-state value of actuating signal.

b) Draw the Bode plot for the system with following transfer function. Also, find the phase margin and the gain margin of the system. Add correction for the second order system. 13

$$G(s)=\frac{(s+2)(s^2+1.4s+9)}{(s+6)(s^2+4.5s+49)}$$

6. a) Root locus is usually plotted for variations in the gain. Sometimes, we are interested in the variation of the closed-loop poles as other parameters are changed. For the system in Fig. 6(a), sketch the root locus as α is varied. 10

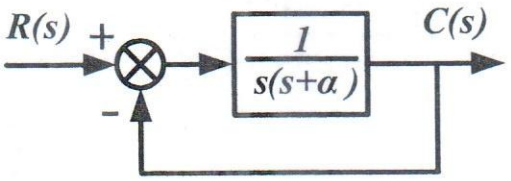

Fig. 6(a)

b) For the unity feedback system shown in Fig. 6(b), where, 15

$$G(s)=\frac{(s+2)(s+3)}{(s^2+2s+2)(s+4)(s+5)(s+6)}$$

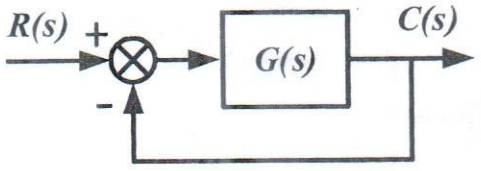

Fig. 6(b)

Do the following:

i. Sketch the root locus,
ii. Find the jω-axis crossing and the gain, K, at the crossing,
iii. Find all breakaway and break-in points,
iv. Find angles of departure from complex poles and
v. Find the gain, K, to yield a damping ratio of 0.3 for the closed-loop dominating poles.

7. a) Fig. 7(a) is a simplified block diagram of a self-guiding vehicle's bearing angle control. Design a lead compensator to yield a closed-loop step response with 10% overshoot and a settling time of 1.5 seconds. 15

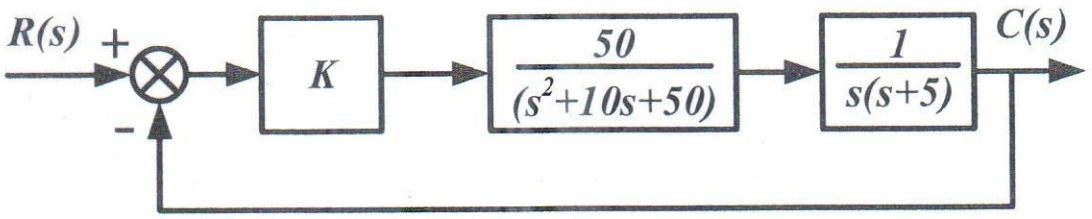

Fig. 7(a)

b) Identify and realize the following compensators with active/passive networks. 10

i. $\frac{s+0.01}{s}$

ii. $s+2$

iii. $\left(\frac{s+0.1}{s+0.01}\right)\left(\frac{s+1}{s+10}\right)$

8. a) Design a lag compensator so that the system of Fig. 8(b) operates with 45^0 phase margin and static error constant of 100. 15

$$G(s)=\frac{K(s+4)}{(s+2)(s+6)(s+8)}$$

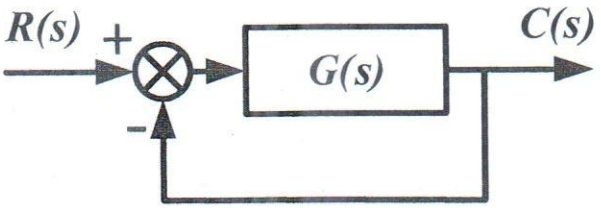

Fig. 8(b)

c) For a certain control system, 10

$$G(s)=\frac{K}{s(s+2)(s+10)},\ H(s)=1$$

Sketch the Nyquist plot and hence, calculate the range of the values of K for stability.

B.Sc. Engg. (EE), 7th Sem. Date: May 27, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 4731 — Time: 3 Hours
Course Title: Power System III — 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. Assume reasonable value for any missing data. Symbols have their usual meanings.

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1. a) The electrical appliances of IUT are randomly turned on/off throughout a day. Which kind of stability should be studied for this sort of load variation? Explain with practical examples. 05

   b) Why is it advantageous to consider the most severe kind of fault while conducting the stability study of a power system? 05

   c) A 50-Hz synchronous generator has a transient reactance of 0.2 per-unit and an inertia constant of 6.0 MJ/MVA. The generator is connected to an infinite bus through a transformer and a double circuit transmission line, as shown in figure 1(c). Resistances are neglected and reactances are expressed on a common base and are marked in the diagram. The mechanical input power to the generator is 0.80 per-unit. The transient internal voltage magnitude is 1.25 per-unit and the infinite bus voltage V_2 is $1.0\angle 0^\circ$ per-unit. 15

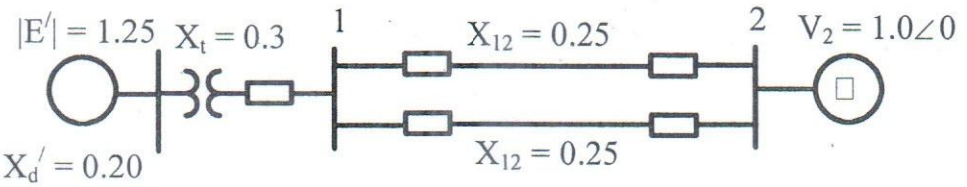

Figure 1(c)

   i) How much real power (P_e) is supplied to the infinite bus?
   ii) Calculate the initial rotor angle at equilibrium state.
   iii) Calculate the current supplied by the generator.
   iv) Find out the voltage phasor at bus 1.
   v) Determine the reactive power (Q_e) supplied at bus 1.

2. The fuel-cost functions for three thermal plants in Tk./h are given by 25

$$C_1 = 350 + 7.20\,P_1 + 0.0040\,P_1^2$$
$$C_2 = 500 + 7.30\,P_2 + 0.0025\,P_2^2$$
$$C_3 = 600 + 6.74\,P_3 + 0.0030\,P_3^2$$

where P_1, P_2 and P_3 are in kW. The total load P_D is 1335 kW. The generator limits in kW are given by

$$122 \le P_1 \le 400$$
$$260 \le P_2 \le 600$$
$$50 \le P_3 \le 445$$

Neglecting line losses, find the optimal dispatch and the total cost in Tk./h by iterative technique using the gradient method. Consider initial estimate of $\lambda = 7.5$ Tk./kWh.

3. a) The phasor diagram of a non-salient pole synchronous generator, operating at lagging power factor under steady state, is shown in figure 3(a). What changes are to be made in this diagram if the machine under consideration has salient poles and is operating in transient state? Show the changes in a separate diagram. 10

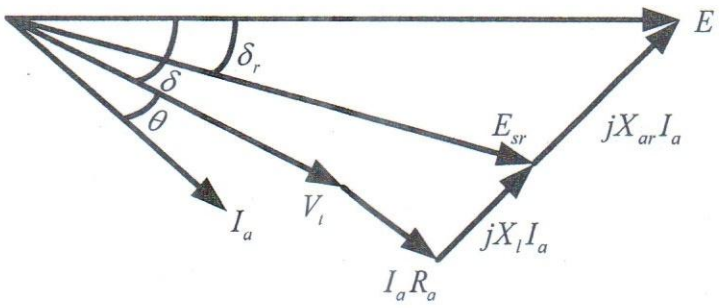

Figure 3(a)

b) Consider a salient-pole synchronous machine characterized by the following parameters: 15
$X_d = 1.6$, $X_q = 1.2$, $X_d' = 0.6$, $R_a = 0$ per unit.
The machine is directly connected to an infinite bus of voltage 1.10 per unit. The amount of real power delivered by the machine is 0.8 per unit at 0.9 power factor lagging. Calculate:
   i) The q-axis transient voltage (E_q') for the machine.
   ii) The steady state excitation voltage (E).
   iii) The torque angle under steady state.
   iv) The d-q components of the current.
   v) The d-q components of the terminal voltage.

4. a) The power angle curve of a single machine infinite bus system is shown in figure 4(a). The steady state operating points are denoted by 'a' and 'b' corresponding to rotor angles δ_0 and δ_{max}, respectively. If the maximum power transfer $P_{emax} = 2.50$ per unit and $\delta_0 = 0.5236$ rad, 10
   i) find out the small disturbance stability of the two points 'a' and 'b' with the help of synchronizing power coefficient (P_s) and
   ii) calculate the natural frequency of oscillation for the two operating points.

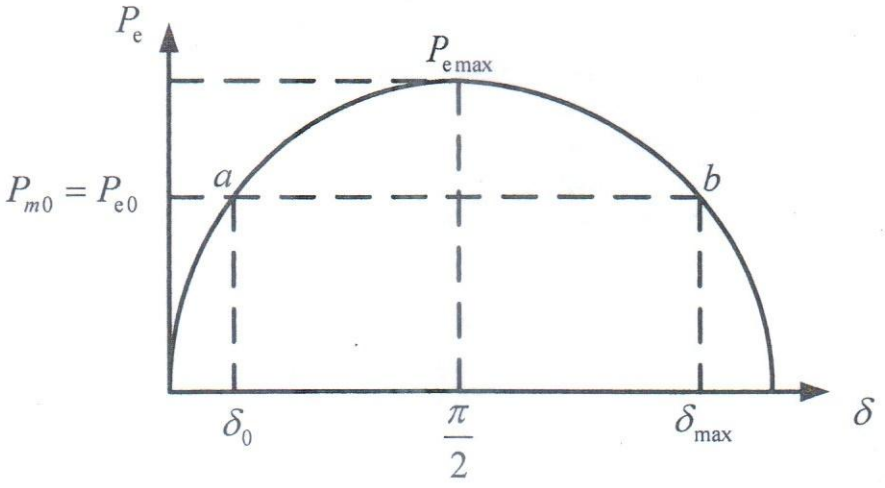

Figure 4(a)

b) The linearized swing equation of a synchronous machine with damping power is represented as $0.0633\frac{d^2\Delta\delta}{dt^2}+0.138\frac{d\Delta\delta}{dt}+1.9884\Delta\delta=0$. 15

i) Compare this equation with the standard 2nd order dynamic equation and find out the values of damped angular frequency (ω_d) and damping ratio (ζ).

ii) Transform this equation into state-space model and find out the eigenvalues of the system matrix A.

iii) Comment on the small-disturbance stability of the system.

5. a) Mention the importance of swing equation in power system stability study. 05

b) Figure 5(b) represents the current injection model of a single machine infinite bus system. Z_{12} is the line impedance between the generator internal voltage node (1) and infinite bus node (2), and Z_{10} and Z_{20} are the self-admittances of the respective nodes. The per-unit impedances of different branches are given as: Z_{12} = j0.8, Z_{10} = j0.5 and Z_{20} = j0.3. The generator internal voltage phasor $E' = 1.3\angle 45^\circ$ and the infinite bus voltage phasor is $V = 1.05\angle 0^\circ$. 20

i) Calculate the Y_{bus} matrix entries of the system.

ii) Determine the injected current phasors I_1 and I_2.

iii) Find out the amount of real power transfer from node 1 to node 2.

iv) Calculate the amount of reactive power transfer between the nodes 1 and 2.

v) Determine the maximum possible real power transfer between the nodes 1 and 2.

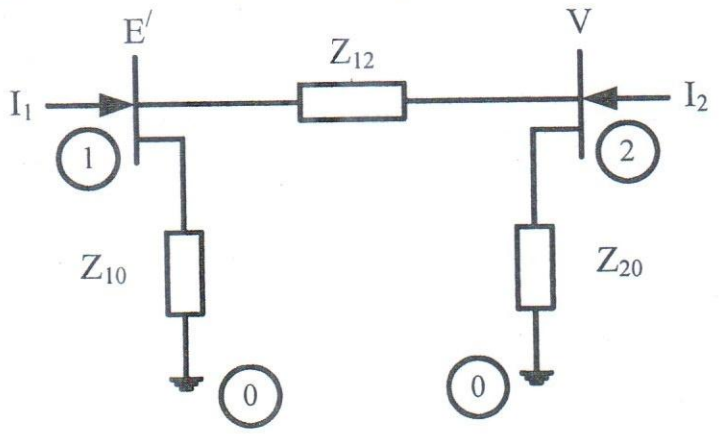

Figure 5(b)

6. Consider a synchronous generator connected to an infinite bus through a transformer and a double circuit transmission line as shown in figure 6. The generator is delivering 0.8 per unit real power at 0.9 power factor lagging to the infinite bus at steady state. Using equal are criterion, find out the transient stability limit and the maximum possible rotor swing (δ_{max}) before losing stability. 25

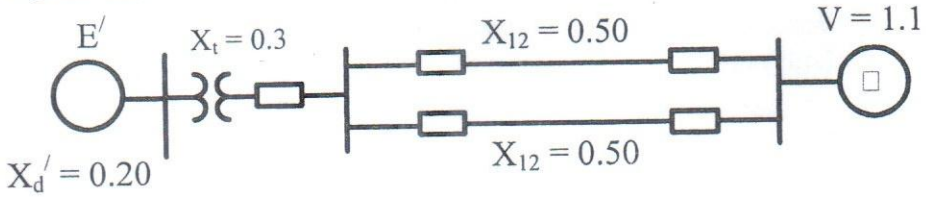

Figure 6

7. A 3-machine 5-bus example power system is shown in figure 7. Generators G_1, G_2 and G_3 are directly connected to buses 1, 2 and 3, respectively. Buses 4 and 5 are carrying complex loads having impedance values $L_4 = 2.8653 + j1.2244$ and $L_5 = 1.8 + j0.4$ per unit. All transmission lines are represented by series impedance $Z_{Line} = j0.1$ per unit. The generator d-axis transient reactances are shown in the figure. 25

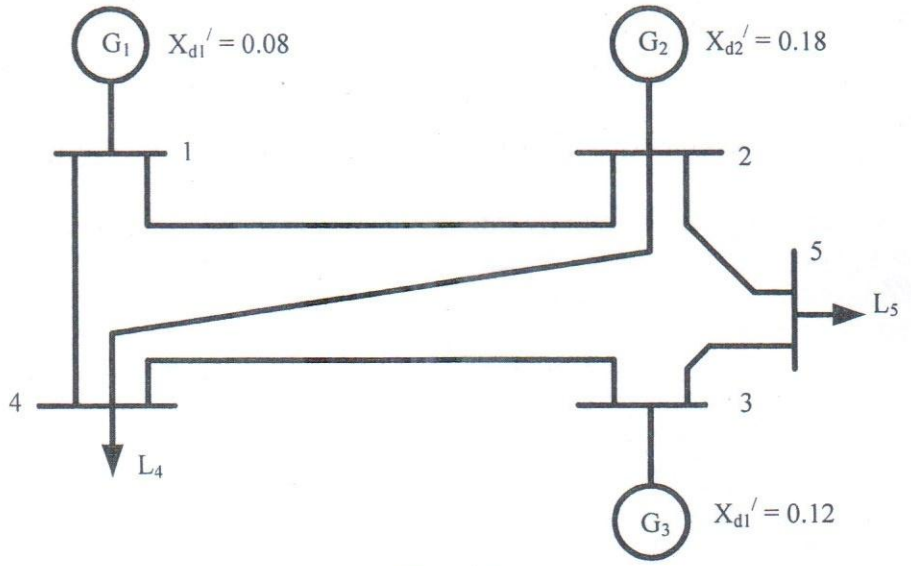

Figure 7

The converged power flow solution for the system is provided below where all the values are in per unit except the voltage phase angles.

$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \end{bmatrix} = \begin{bmatrix} 1.04\angle 0^o \\ 1.02\angle -3.55^o \\ 1.05\angle -2.90^o \\ 0.9911\angle -7.48^o \\ 1.0135\angle -7.05^o \end{bmatrix}, \quad \begin{bmatrix} P_{G1} \\ P_{G2} \\ P_{G3} \end{bmatrix} = \begin{bmatrix} 1.9991 \\ 0.6661 \\ 1.60 \end{bmatrix}, \quad \begin{bmatrix} Q_{G1} \\ Q_{G2} \\ Q_{G3} \end{bmatrix} = \begin{bmatrix} 0.8134 \\ 0.2049 \\ 1.051 \end{bmatrix}$$

i) Calculate the pre-fault Y_{bus} (5-by-5) matrix.
ii) Modify the Y_{bus} matrix of step (i) by incorporating generator transient reactances.
iii) Obtain the during-fault Y_{bus} matrix considering occurrence of a three phase to ground fault at line 3-4 (near bus 4).
iv) Find out the post-fault Y_{bus} matrix considering the clearance of the fault by isolation of line 3-4.
v) Calculate the generator internal voltages.
vi) Write down the swing equations corresponding to pre-fault, during-fault and post-fault periods.

8. A 50-Hz synchronous generator has an inertia constant of 5.0 MJ/MVA. The generator is connected to an infinite bus through a double circuit transmission line as shown in figure 8. The generator is delivering complex power $S = 0.9 + j0.1$ to the infinite bus. 25

i) A temporary three phase fault occurs at the sending end of the line at point F_1. When the fault is cleared, both lines are intact. Calculate the critical clearing angle and critical clearing time.

ii) A three phase fault occurs at the middle of one of the lines (say, at point F_2). The fault is cleared by isolating the faulty line. Calculate the critical clearing angle.

iii) Show the accelerating area, the decelerating area and the post-fault equilibrium point on power-angle curves for both cases.

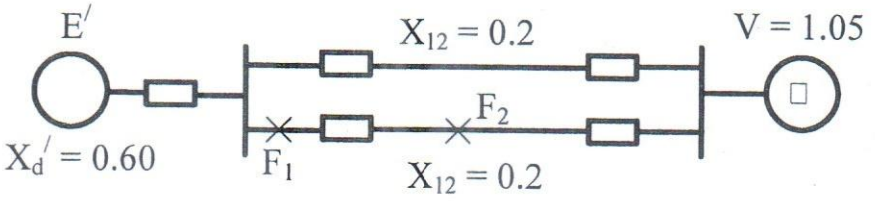

Figure 8

Formula Sheet

Three phase real power output- Non-salient pole machine (steady state): $P_{(3\phi)} = 3\frac{|E||V|}{X_s}\sin\delta$

Three phase reactive power output- Non-salient pole machine (steady state): $Q_{(3\phi)} = 3\frac{|V|}{X_s}(|E|\cos\delta - |V|)$

Generator internal voltage: $\overline{E} = \overline{V} + jX_s\overline{I}_a + \overline{I}_aR_a$

Swing Equation: $\frac{d^2\delta_e}{dt^2} = \frac{\omega_e}{2H}(P_m - P_e)$

Real power output- Salient pole machine (steady state): $P_e = \frac{|E||V|}{X_d}\sin\delta + \frac{|V|^2}{2}\frac{X_d - X_q}{X_dX_q}\sin 2\delta$

Rotor angle: $\delta = \tan^{-1}\frac{X_q|I_a|\cos\theta}{|V|+X_q|I_a|\sin\theta}$

Real power output- Salient pole machine (transient state): $P_e = \frac{|E'_q||V|}{X'_d}\sin\delta + \frac{|V|^2}{2}\frac{X'_d - X_q}{X'_dX_q}\sin 2\delta$

q-axis internal voltage magnitude (transient): $|E'_q| = \frac{X'_d|E|+(X_d - X'_d)|V|\cos\delta}{X_d}$

Natural angular frequency of oscillation: $\omega_n = \sqrt{\frac{\pi f_0 P_s}{H}}$

Synchronizing power coefficient: $P_s = P_{max}\cos\delta_0$

Damping ratio: $\zeta = \frac{D}{2}\sqrt{\frac{\pi f_0}{HP_s}}$

Damped angular frequency: $\omega_d = \omega_n\sqrt{1-\zeta^2}$

Rotor angle: $\delta(t) = \delta_0 + \frac{\Delta\delta_0}{\sqrt{1-\zeta^2}}e^{-\zeta\omega_n t}\sin(\omega_d t + \theta)$

Rotor angular velocity: $\omega(t) = \omega_0 - \frac{\omega_n\Delta\delta_0}{\sqrt{1-\zeta^2}}e^{-\zeta\omega_n t}\sin\omega_d t$

Maximum rotor swing (iterative): $\Delta\delta_{max}^{(k)} = \frac{c - f(\delta_{max}^{(k)})}{(\delta_{max}^{(k)} - \delta_0)\cos\delta_{max}^{(k)}}$

Updating rotor angle (iterative): $\delta_{max}^{(k+1)} = \delta_{max}^{(k)} + \Delta\delta_{max}^{(k)}$

Critical clearing angle: $\cos\delta_c = \frac{P_m}{P_{max}}(\delta_{max} - \delta_0) + \cos\delta_{max}$

Critical clearing time: $t_c = \sqrt{\frac{2H(\delta_c - \delta_0)}{\pi f_0 P_m}}$

Critical clearing angle: $\cos\delta_c = \frac{P_m(\delta_{max} - \delta_0) + P_{3max}\cos\delta_{max} - P_{2max}\cos\delta_0}{P_{3max} - P_{2max}}$

Mechanical power input: $P_m = P_{max}\sin\delta_0$

Maximum power: $P_{max(bf/df/af)} = \frac{|E'||V_b|}{X_{eq(bf/df/af)}}$

Fuel cost: $C_i = \alpha_i + \beta_iP_i + \gamma_iP_i^2$

Incremental fuel cost: $\frac{dC_i}{dP_i} = \beta_i + 2\gamma_iP_i$

Plant generation: $P_i = \frac{\lambda - \beta_i}{2\gamma_i}$

Incremental cost: $\lambda = \frac{P_D + \sum_{i=1}^{n_g}\frac{\beta_i}{2\gamma_i}}{\sum_{i=1}^{n_g}\frac{1}{2\gamma_i}}$

Change in incremental cost (iterative): $\Delta\lambda^{(k)} = \frac{\Delta P^{(k)}}{\Sigma\frac{1}{2\gamma_i}}$

Error in power (iterative): $\Delta P^{(k)} = P_D - \sum_{i=1}^{n_g}P_i^{(k)}$

B.Sc. Engg. (EEE), 7th Sem. Date: May 29, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: EEE 4741
Course Title: Optical Communication

Winter Semester, A. Y. 2018-2019
Time: 3 Hours
Full Marks: 150

There are **8 (eight)** questions. Answer **any 6 (six)** questions. All questions carry equal marks. Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. All symbols bear their usual meaning. Assume reasonable values for missing data.

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1. a) What was the wavelength of operation and material used for first generation of lightwave system? Why was 1.3 μm wavelength chosen for second generation lightwave system? Why could not conventional InGaAsP lasers be used for third generation system? 2+3+2

   b) Compare between RZ and NRZ modulation formats of the resulting optical bit-stream. Explain SONET, SDH and STM with their respective bit rates. Name the SONET equivalent of STM-64 and mention its channel number along with bit rate. 5+9+4

2. a) Which are the suitable dopants of core and cladding for silica based optical fibers? Mention the two stages for fabrication of telecommunication-grade silica fibers. Explain depressed and raised cladding fibers with different index profile. 2+3+5

   b) Calculate the bit-rate distance product for a cladded graded-index fiber with $n_1 = 1.5$, $n_2 = 1.497$. Find out the index profile α for minimum dispersion in this case. Compare this α value with that of parabolic index profile. 7

   c) Explain when a mode reaches cutoff using p and q parameters from Helmholtz equation in cylindrical coordinates. How does dry fiber assist in reducing extrinsic absorption loss? 5+3

3. a) State the differences between SRS and SBS. Discuss FWM in optical fiber. 3+6

   b) Explain -"Indeed, an optical amplifier is nothing but a laser without feedback". 4

   c) What makes optical amplifier a better solution for WDM lightwave systems? Explain three possible applications of optical amplifiers in lightwave system. 2+5

   d) Describe the operating principle of Raman amplification in terms of forward pumping. 5

4. a) State and show the fundamental processes that occur between the two energy states of an atom for optical transmission. Define spontaneous and stimulated emission. Explain radiative and non-radiative recombination of semiconductor materials. 5+4

   b) Explain the carrier confinement problem of homojunction. How does a slightly smaller bandgap of active layer assist in the light confinement process of heterostructure? 3+3

   c) Define and explain the wall-plug efficiency and responsivity from the power-current characteristics of LED. Find out the typical values of internal quantum efficiency for both direct and indirect bandgap semiconductors from their respective recombination times. 5+5

5. a) What is the use of gold stud in surface emitting LED and how is coupling efficiency improved? Why is epoxy added in the etched well? 6

   b) How is optical gain achieved in stimulated emission? Explain optical feedback and laser threshold current. Show the basic structure of a semiconductor laser and Fabry-Perot cavity associated with it. 4+4+4

   c) Define optoelectronic integration. Why should t_F exceed 10^5 hours for the optical source? State the main difference between DFB and DBR laser. 2+2+3

6. a) How is p-i-n diode advantageous over p-n diode as a photodetector? Briefly mention the basic principle behind avalanche photodiode. 6+4

   b) Draw the diagram of a digital optical receiver showing various components. Define timing jitter and extinction ratio of an optical receiver. 4+4

   c) Compare between a typical bus and passive star topology based lightwave system using insertion loss $\delta = 0.05$, fraction of power coupled at each tap $C = 0.05$, transmitter power 1 mW and power available at Nth tap or user = 0.1 μW. 7

7. a) Find out the bit-rate of a loss-limited light-wave system at 1.3 μm wavelength for which the transmission power is taken to be 1 mW, the net loss is 0.4 dB/km and the average number of photons/bit is found as 450. Consider maximum transmission distance as 15 km. 8

   b) How does dispersion induced pulse broadening affect the receiver performance? What are the sources of power penalty? Define frequency chirping. 3+3+2

   c) A 1.3μm long-haul lightwave system is designed to operate at 1.5 Gb/s. It is capable of coupling 1 mW of average power into the fiber. The 0.5 dB/km fiber cable loss includes splice losses. The connectors at each end have 1 dB losses. The InGaAs p–i–n receiver has a sensitivity of 250 nW. Make the power budget and estimate the repeater spacing. 9

8. a) Why is external optical modulator necessary for higher bit rates? Name two types of external optical modulator. How is the performance of an external modulator quantified? 6

   b) Derive the expression of quantum efficiency of a photodetector in terms of absorption coefficient and slab width. Define cut-off wavelength from the wavelength dependence of the absorption coefficient. 6+3

   c) Explain trade-off between bandwidth and responsivity of a photodetector. What will be the bandwidth of the photodetector while both transit time and RC time constant being 100 ps? What would you do to increase the bit rate of the lightwave system to 10 Gb/s? 5+5

B.Sc. Engg.(EEE) 7th Sem. Date: May 29, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A.Y. 2018-2019
Course No.: EEE 4765 — Time: 3 Hours
Course Title: Embedded System Design — 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) Details of three processes are provided in the following table: 16

Processes	Computation Time (C)	Period (T)
a	40	80
b	10	40
c	5	20

Considering the task priority, check the UB test in every step. Make necessary response time analysis for each task. Combine UB test and precise test to comment on the schedulability.

b) How to overcome the drawback of Serial Peripheral Interface (SPI) using I^2C Connection? With relevant diagram explain the main features of I^2C Bus Connection. 3+3

c) What are different forms of Redundancies we deal in Fault Tolerance? 3

2. a) Show daisy-chained SPI connection of single master and multiple slaves. 5

b) Mention various states of a process with necessary diagrams. 5

c) What is the difference between *std_logic* and *std_ulogic*? 4

d) Discuss the significance of liveness in petri-net modeling. 6

e) Why "*wait for*" statement is non-synthesizable**?** 5

3. a) Assume a system with tasks with timing properties according to the table below. 10

Task	C_i	T_i
A	1	3
B	1	4
C	1	5
D	1	5

i) What is the utilization of the task set?
ii) What is the outcome of Liu & Layland's feasibility test for Earliest Deadline First (EDF) algorithm?
iii) Show that the tasks are not schedulable using RMS (Rate Monotonic Scheduling).
iv) Show that the tasks are schedulable using EDF.

b) Briefly explain the following terms: Internet of Things (IoT), Complex Event Processing (CEP), IPv6, Natural Language Processing. 8

c) With diagram explain Triple Modular Redundancy and voting system. 7

4. a) With necessary diagrams explain mesh-based routing architecture in FPGA. 7

b) What is the advantage of BLTE over Bluetooth classic? 4

c) Show the steps of SPI data transmission. 4

d) There are four states in the finite state machine (FSM): A, B, C, and D shown in Fig. 4(d). The system has one input signal called P, and the value of P determines which state of 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. The arrow coming from "nowhere" to the A indicates that A is the initial state. 10

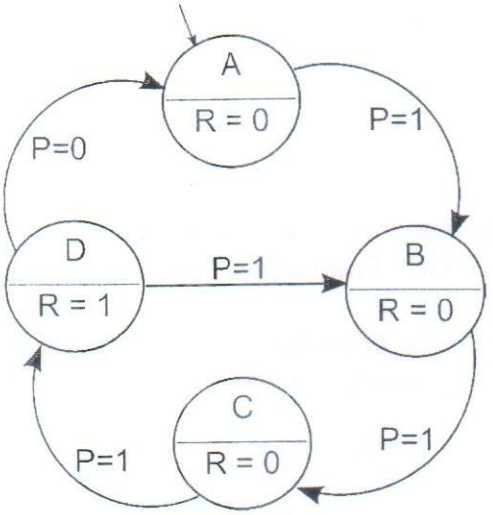

Fig. 4(d)

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

5. a) Assume a system with task sets: {(1,3), (1, 5), (1, 6), (2, 10)}. 10
i) What is the utilization of the task set?
ii) What is the outcome of Liu & Layland's feasibility test for RMS?
iii) Show that the tasks are schedulable using RMS.

b) Express petri-net with formal mathematical definition. 5

c) With necessary diagrams explain synthesis process in VHDL. 6

d) What is connection box and switch box? 4

6. a) What is deadlock in operating systems? 4

b) Write the code expressions to declare the library of a watchdog timer, enabling and resetting of the timer in Arduino? 6

c) Show daisy-chained SPI connection of single master and multiple slaves. 5

d) Draw the reachability tree and reachability graph for the Fig. 6(d). 10

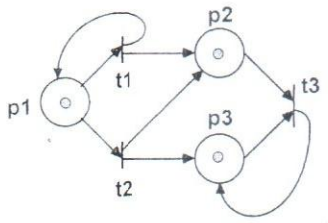

Fig. 6(d)

7. a) What is an Antifuse? What are the main components of a BLE? 3+7

b) Illustrate the relation between system calls and context switch. 6

c) Mention the steps of generic FPGA design flow. What is the significance of place and route? 3+3

d) How to generate an infinite loop in VHDL? 3

8. a) Graphically show arrival time, release time, computing time and deadline of a periodic task. 4

b) What is the function of a watchdog timer in embedded systems? 5

c) Draw the reachability tree and reachability graph for the Fig. 8(c) 10

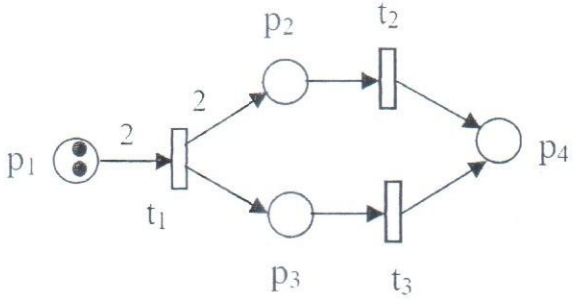

Fig. 8(c)

d) Find the incidence matrix for the Fig. 8(c). 6

BSc TE (1-yr), 1st Semester
BSc TE (2-yr), 3rd Semester

Date: May 21, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No. EEE 4793
Course Title: Advanced Electronics I

Winter Semester, A.Y. 2018-2019
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) Define contact potential. Derive the equation for contact potential (in terms of donor and acceptor ions) when a p and n-type materials are brought close together to form a junction. 15

   b) An abrupt Si p-n junction has N_a=$10^{18} cm^{-3}$ on one side and N_d=$5 \times 10^{15} cm^{-3}$ on the other side. 10
   i) Calculate the Fermi level positions at 300 K in the p and n regions.
   ii) Draw an equilibrium band diagram for the junction and determine the contact potential V_0 from the diagram.

2. a) Discuss qualitative effects of bias on the important features of the junction such as transition region width and electric field, electrostatic potential, energy band diagram, and particle flow and current directions within W in details for 12
   i) Equilibrium,
   ii) Forward bias, and
   iii) Reverse bias.

   b) Derive the equations for the distribution of minority carriers on each side of a p-n junction when forward biased. Also, derive diode current equation. 13

3. a) Show schematically the electron and hole components of current in a forward-biased p-n junction. From the diagram, discuss the change in majority and minority carrier currents near and away from the junction. 12

   b) An abrupt Si p-n junction (A=$10^{-4} cm^2$) has the following properties at 300 K: 13

p side	n side
N_a=$10^{17} cm^{-3}$, τ_p=10 μs	N_d=$10^{15} cm^{-3}$, τ_n= 0.1 μs
μ_p= 450	μ_n= 700

   The junction is forward biased by 0.5 V. What is the forward current?
   What is the current at a reverse bias of -0.5 V?

4. a) Explain time variation of stored charge for a step turn-off transient, in which the current I is suddenly removed at t = 0. Derive exponential decay equation of stored charge Q_p(t). 14

   b) Assume a p-n junction diode is biased in the forward direction with a current I_f. At time t = 0 the current is switched to -I_r. Use appropriate boundary conditions to solve for $Q_p(t)$. Apply quasi-steady state approximation to find the storage delay time t_{sd}. 11

5. a) Derive the equation for the junction capacitance due to dipole in the transition region. 13

   b) What is photovoltaic effect? Derive the equations for current and voltage of a photodiode. 12

6. Write short notes on the following. 25
   i) Avalanche Breakdown
   ii) Zener Breakdown
   iii) Solar cells
   iv) Photodetectors

7. a) Briefly explain direct and indirect semiconductors. From (E|K) diagram, describe direct and indirect electron transition in semiconductors. 8

   b) Define fermi-dirac distribution function. What will be the shape of fermi-dirac distribution function at T= 0 K and also at higher temperatures for the following cases: 8
   (i) $E < E_F$ (ii) $E > E_F$ (iii) $E = E_F$

   c) A Si sample is doped with 10^{17} As atoms/ cm^3.What is the equilibrium hole concentration $n_0$at 300 K? Where is E_F relative to E_i ? (n_i=1.5×10^{10}, *assuming* n_0=N_d). 9

8. a) Briefly explain optical absorption process in semiconductors. Also Discuss dependence of optical absorption coefficient "α" on the wavelength of incident light. 10

   b) Derive the equations for the instantaneous concentrations of excess carriers δn(t) and δp(t) after a short flash of light is applied at t = 0. Write the expression for carrier life time. 10

   c) A 0.46 μm/thick sample of GaAs is illuminated with monochromatic light of hγ = 2eV. The absorption coefficient α is 5×10^4 cm^{-1}. The power incident on the sample is 10 mW. Find the total energy absorbed by the sample per second (J/s). 5

List of important formulas

Fermi-Dirac e^- distribution: $f(E) = \dfrac{1}{e^{(E-E_F)/kT}+1} \cong e^{(E_F-E)/kT}$ for $E \gg E_F$ (3–10)

Equilibrium: $n_0 = \displaystyle\int_{E_c}^{\infty} f(E)N(E)dE = N_c f(E_c) = N_c e^{-(E_c-E_F)/kT}$ (3–15)

$N_c = 2\left(\dfrac{2\pi m_n^* kT}{h^2}\right)^{3/2}$ $N_v = 2\left(\dfrac{2\pi m_p^* kT}{h^2}\right)^{3/2}$ (3–16), (3–20)

$p_0 = N_v[1 - f(E_v)] = N_v e^{-(E_F-E_v)/kT}$ (3–19)

$n_i = N_c e^{-(E_c-E_i)/kT}$, $p_i = N_v e^{-(E_i-E_v)/kT}$ (3–21)

$n_i = \sqrt{N_c N_v}\, e^{-E_g/2kT} = 2\left(\dfrac{2\pi kT}{h^2}\right)^{3/2}(m_n^* m_p^*)^{3/4} e^{-E_g/2kT}$ (3–23), (3–26)

Equilibrium: $n_0 = n_i e^{(E_F-E_i)/kT}$, $p_0 = n_i e^{(E_i-E_F)/kT}$ (3–25) $\qquad n_0 p_0 = n_i^2$ (3–24)

Steady state: $n = N_c e^{-(E_c-F_n)/kT} = n_i e^{(F_n-E_i)/kT}$, $p = N_v e^{-(F_p-E_v)/kT} = n_i e^{(E_i-F_p)/kT}$ (4–15) $\qquad np = n_i^2 e^{(F_n-F_p)/kT}$ (5–38)

$\mathscr{E}(x) = -\dfrac{dV(x)}{dx} = \dfrac{1}{q}\dfrac{dE_i}{dx}$ (4–26)

Poisson: $\dfrac{d\mathscr{E}(x)}{dx} = -\dfrac{d^2V(x)}{dx^2} = \dfrac{\rho(x)}{\epsilon} = \dfrac{q}{\epsilon}(p - n + N_d^+ - N_a^-)$ (5–14)

$\mu \equiv \dfrac{q\bar{t}}{m^*}$ (3–40a) $\qquad$ Drift: $v_d \cong \dfrac{\mu\mathscr{E}}{1 + \mu\mathscr{E}/v_s}\begin{cases} = \mu\mathscr{E} \text{ (low fields, ohmic)} \\ = v_s \text{ (high fields, saturated vel.)} \end{cases}$ (Fig. 6-9)

Drift current density: $\dfrac{I_x}{A} = J_x = q(n\mu_n + p\mu_p)\mathscr{E}_x = \sigma\mathscr{E}_x$ (3–43)

Conduction Current:

$$J_n(x) = q\mu_n n(x)\mathscr{E}(x) + qD_n\frac{dn(x)}{dx}$$

drift diffusion (4–23)

$$J_p(x) = q\mu_p p(x)\mathscr{E}(x) - qD_p\frac{dp(x)}{dx}$$

$$J_{\text{total}} = J_{\text{conduction}} + J_{\text{displacement}} = J_n + J_p + C\frac{dV}{dt}$$

List of important formulas

Continuity: $\frac{\partial p(x,t)}{\partial t} = \frac{\partial \delta p}{\partial t} = -\frac{1}{q}\frac{\partial J_p}{\partial x} - \frac{\delta p}{\tau_p} \qquad \frac{\partial \delta n}{\partial t} = \frac{1}{q}\frac{\partial J_n}{\partial x} - \frac{\delta n}{\tau_n}$ (4–31)

For steady state diffusion: $\frac{d^2\delta n}{dx^2} = \frac{\delta n}{D_n \tau_n} \equiv \frac{\delta n}{L_n^2} \qquad \frac{d^2\delta p}{dx^2} = \frac{\delta p}{L_p^2}$ (4–34)

Diffusion length: $L \equiv \sqrt{D\tau}$ Einstein relation: $\frac{D}{\mu} = \frac{kT}{q}$ (4–29)

Capacitance: $C = \left|\frac{dQ}{dV}\right|$ (5-55)

Junction Depletion: $C_j = \epsilon A\left[\frac{q}{2\epsilon(V_0 - V)}\frac{N_d N_a}{N_d + N_a}\right]^{1/2} = \frac{\epsilon A}{W}$ (5-62)

Stored charge exp. hole dist.: $Q_p = qA\int_0^\infty \delta p(x_n)dx_n = qA\Delta p_n\int_0^\infty e^{-x_n/L_p}dx_n = qAL_p\Delta p_n$ (5-39)

$I_p(x_n = 0) = \frac{Q_p}{\tau_p} = qA\frac{L_p}{\tau_p}\Delta p_n = qA\frac{D_p}{L_p}p_n(e^{qV/kT} - 1)$ (5-40)

$G_s = \frac{dI}{dV} = \frac{qAL_p p_n}{\tau_p}\frac{d}{dV}(e^{qV/kT}) = \frac{q}{kT}I$ (5-67c)

Long p^+-n: $i(t) = \frac{Q_p(t)}{\tau_p} + \frac{dQ_p(t)}{dt}$ (5-47)

M.Sc. Engg./ PhD (EE) Date: May 24, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A.Y. 2018-2019
Course No.: EEE 6307 — Time: 3 Hours
Course Title: Power System Modeling — Full Marks: 150

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

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1. a) The variation of the permeance (as a function of rotor position) in the air gap of a salient pole synchronous machine is shown in Figure 1(a). Discuss the reason behind the nature of this variation. 05

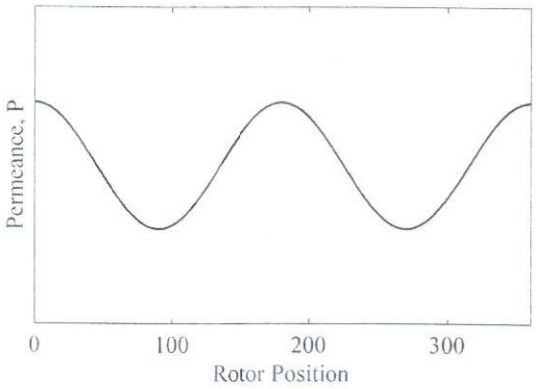

Figure 1(a)

b) The rotor-rotor inductance matrix of a salient pole synchronous generator is represented as $L_{rr} = \begin{bmatrix} L_{fd}L_{fd} & L_{fd}L_{1d} & 0 & 0 \\ L_{1d}L_{fd} & L_{1d}L_{1d} & 0 & 0 \\ 0 & 0 & L_{1q}L_{1q} & L_{1q}L_{2q} \\ 0 & 0 & L_{2q}L_{1q} & L_{2q}L_{2q} \end{bmatrix}$. What do the 0's stand for in the matrix? Explain in short. 05

c) Given a balanced set of three-phase current as $\begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} = \begin{bmatrix} I_m \cos(\omega_s t) \\ I_m \cos(\omega_s t + 120^\circ) \\ I_m \cos(\omega_s t - 120^\circ) \end{bmatrix}$, and the abc-dq0 transformation matrix as $T_{dq0} = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos(\theta_s) & \cos(\theta_s - 120^\circ) & \cos(\theta_s + 120^\circ) \\ -\sin(\theta_s) & -\sin(\theta_s - 120^\circ) & -\sin(\theta_s + 120^\circ) \\ \sqrt{\frac{1}{2}} & \sqrt{\frac{1}{2}} & \sqrt{\frac{1}{2}} \end{bmatrix}$, find out the corresponding values of currents in dq0 reference frame. 15

2. The third order flux-decay model of a salient-pole synchronous generator is presented as 25

$$\dot{\delta} = \omega_0(\omega - 1)$$

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

$$\dot{E}'_q = \frac{1}{T'_{d0}}\left[E_{fd} - E'_q - (X_d - X'_d)I_d\right]$$

where, $P_e = V_d I_d + V_q I_q$, $I_d = \dfrac{E'_q - V_b \cos\delta}{X'_d + X_L}$, $I_q = \dfrac{V_b \sin\delta}{X_q + X_L}$, $V_d = X_q I_q$ and $V_q = E'_q - X'_d I_d$

The generator supplying real power, $P_t = 0.9$ p.u and reactive power, $Q_t = 0.2$ p.u with terminal with voltage $V_t = 1.0$ p.u. It is connected to an infinite bus system having voltage V_b through a transmission line having reactance $X_L = 0.15$ p.u. The generator is not equipped with automatic voltage regulator (AVR). The machine parameters (in p.u except otherwise stated) are given as follows:

Parameter	Value	Parameter	Value
H	6.0	D	0.0
X_d	1.6	X_q	1.2
X_d'	0.8	T_{do}'	4 sec.
F	50 hz.		

i) Calculate the initial values of the system variables.
ii) Obtain the linearized dynamic model of the system and compute the eigenvalues.
iii) Comment on the stability of the system.

3. a) The terminal voltage magnitude of a synchronous generator can be expressed in terms of its d-q components as $V_t = \sqrt{V_d^2 + V_q^2}$. The generator excitation system senses this voltage and compares against a preset value of reference voltage V_{ref}. Any output error of this comparator is taken care of by the exciter block. Obtain the linearized dynamic model of the simplified exciter block and derive the expressions of the associated linearizing constants K_5 and K_6. 10

b) Establish the Philips-Heffron transfer function block representation of a single machine infinite bus system where the generator is equipped with an exciter. 15

4. The block diagram representation of a speed-input power system stabilizer (PSS) is shown in Figure 4. The PSS is to be incorporated into a single machine infinite bus system (SMIB) to improve damping. The numerical data and K-constants are listed in the following table. 25

Parameter	Value	Parameter	Value
H	3.2	D	0.0
K	400	T	0.2
F	50 hz	ω_0	$2\pi f$
K_1	0.9223	K_2	1.0737
K_3	3.3708	K_4	2.2655
K_5	0.0050	K_6	0.3572

i) Mention the purpose of using the wash-out block.
ii) Derive the state equations associated with the PSS block.
iii) Calculate the undamped natural frequency of oscillation, ω_n.
iv) Calculate the phase lag produced in the electrical loop of the SMIB system.
v) Design the required number of phase lead block(s) (T_1 and T_2) for compensating the phase lag produced in part (iv).
vi) Design the gain block (K_{pss}) for introducing desired damping effect ($\Im = 0.3$).

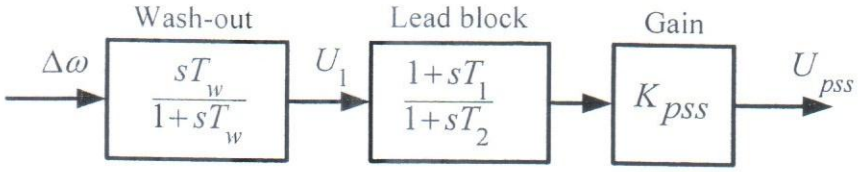

Figure 4

5. a) Figure 5a shows the schematic diagram of a hydro-turbine power plant along with its essential components. Let H be the height of water level in the reservoir, U the water velocity and G the gate position. Obtain the small signal dynamic model of the plant. 12

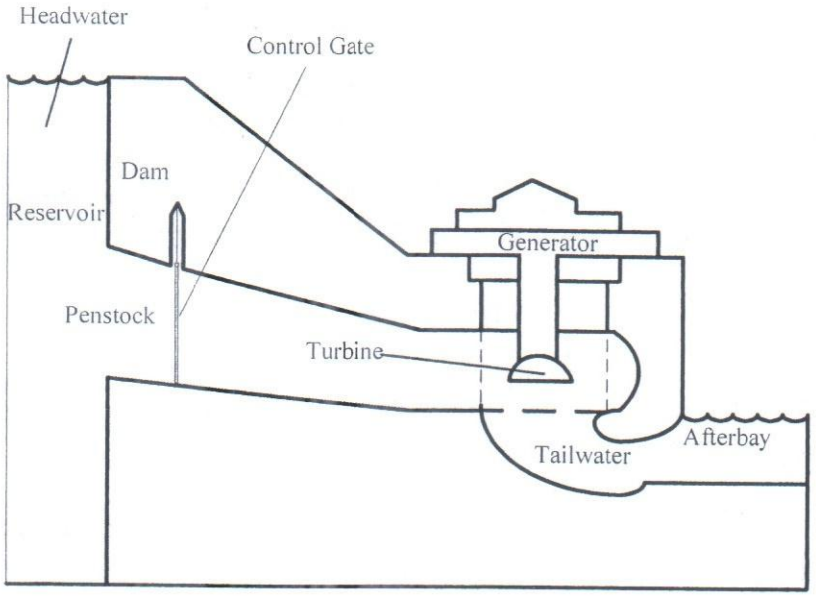

Figure 5a

b) Figure 5b represents the schematic diagram of a flyball based speed governing mechanism of a steam power plant. Discuss the operation of this mechanism once a drop or rise in speed is sensed by the flyball. 13

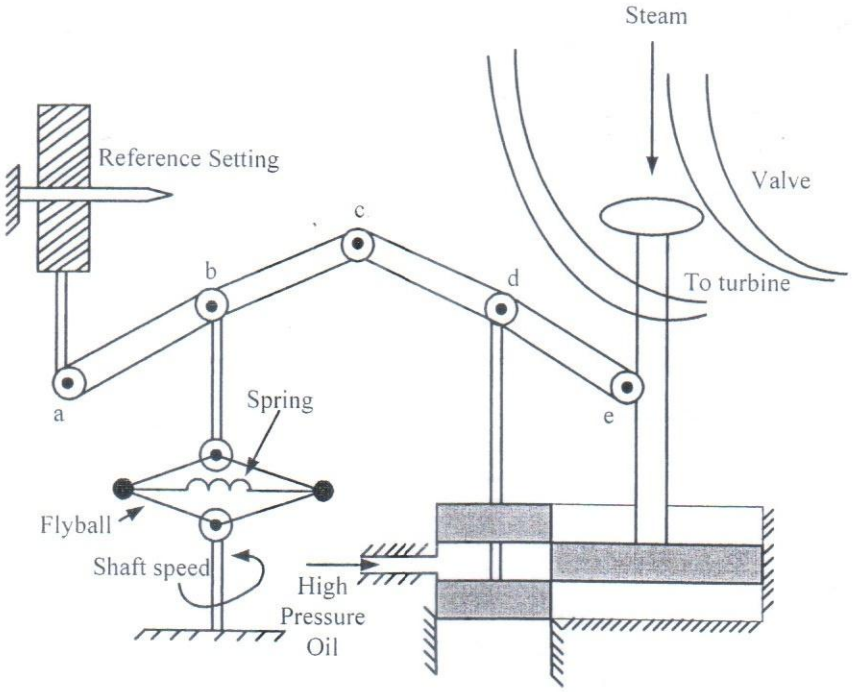

Figure 5b

6. a) Why is it required to consider different abc-dq0 transformation matrix for the stator and rotor variables of a three-phase induction machine? 05

b) Discuss the three components of power developed in the rotor of a three-phase induction machine. Which one of those goes to zero during steady state? 05

c) Derive the per-unitized equation of motion of an induction machine. 05

d) The *A*-axis of the rotor of a three-phase induction machine is $\theta = 30°$ away from the stator *a*-axis. If the maximum value of the stator-rotor mutual inductance is $l_{aA} = 0.5$ henry, calculate the numerical values of the elements of the L_{sr} matrix. 10

7. Figure 7 shows the one-line diagram of a single machine infinite bus power system equipped with a static synchronous compensator (STATCOM). The per unit numerical data (except otherwise stated) associated with the system is provided in the following table. 25

Parameter	Value	Parameter	Value
X_d	1.0	X_q	0.8
X_d'	0.55		
$\|V_t\|$	1.05	$\|V_s\|$	1.05
$\|V_b\|$	1.05	P_t	1.0
X_{ts}	0.3	X_{sb}	0.3
X_s	0.15	V_{dc}	1.2
k_c	3.0		

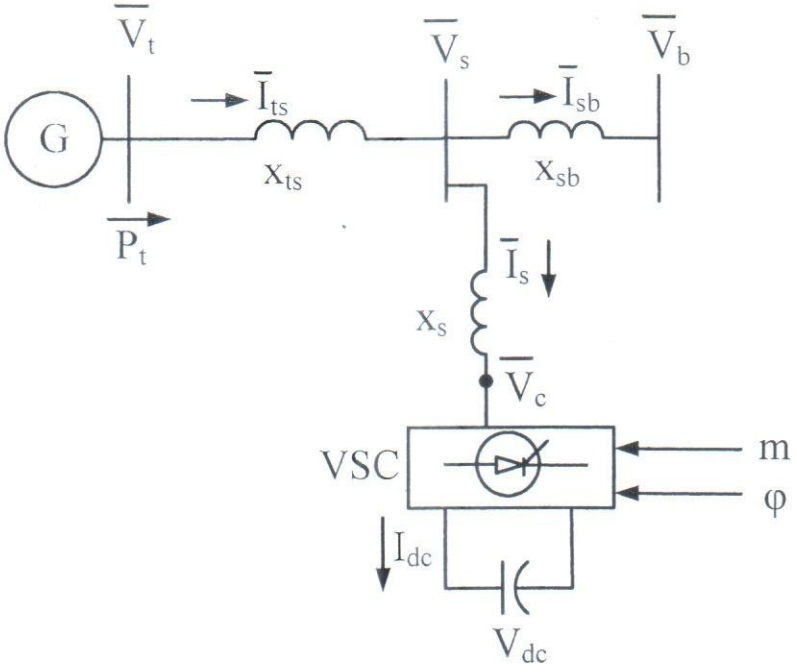

Figure 7

i) Obtain the expression of reactive power supplied to the infinite bus, Q_b.
ii) Derive the expression of the dc capacitor current (I_{dc}).
iii) Calculate the values of the phasors $\bar{V}_t$, $\bar{V}_s$ and $\bar{V}_c$.
iv) Determine the value of the modulation index (m) and phase angle (φ) of the voltage source converter (VSC).
v) Find out the dq components of all the phasors from the phasor diagram of the system.

8. The nonlinear dynamic model of a PSS equipped SMIB system is given as 25

$$\dot{\delta} = \omega_0(\omega - 1)$$

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

$$\dot{E}'_q = \frac{1}{T'_{d0}}\left[E_{fd} - E'_q - (X_d - X'_d)I_d\right]$$

$$\Delta\dot{E}_{fd} = \frac{K}{T}\left[V_{ref} - V_t + U_{pss}\right] - \frac{K}{T}\Delta E_{fd}$$

$$\dot{U}_1 = \dot{\omega} - \frac{1}{T_w}U_1$$

$$\dot{U}_{pss} = K_{pss}\frac{U_1}{T_2} - \frac{U_{pss}}{T_2} + K_{pss}\frac{T_1}{T_2}\dot{U}_1$$

Prepare a MATLAB script file to simulate the time domain response using Euler method of numerical integration. Consider the system is running at steady state up to 0.1 sec and then a mechanical torque (step) input of 0.1 per unit is provided to the generator shaft as a disturbance. Take simulation time step, $\Delta t = 0.001$ sec and total simulation time = 5.0 sec.

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M.Sc.TE (2 Yr), 3rd Sem. Date: May 24, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: EEE 6393
Course Title: Energy Conversion

Winter Semester, A. Y. 2018-2019
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) Define the following terms with appropriate equation: 06
   i) Power balance
   ii) Conversion efficiency
   iii) Steady state conversion efficiency

   b) Classify different generations of solar cells with example. What were the disadvantages of Si wafer solar cell that prompted the development of next generation solar cells? 06+03

   c) State the input energy, output energy and typical conversion efficiency for following energy conversion devices: 10
   i) Electric motor
   ii) Electric generator
   iii) Incandescent lamp
   iv) Battery
   v) Wind turbine

2. a) Define following terms in regards to a solar PV system: 08
   i) Balance of system
   ii) Hard cost
   iii) Soft cost
   iv) Net metering

   b) Why doping is performed in a solar cell material? 02

   c) Design solar PV system for a house with following appliances: 15
   i) Six 15 W lamp used for 6 hours a day,
   ii) Three 60 W fan used for 8 hours a day and
   iii) One 100 W refrigerator with compressor running for 12 hours a day
   The system will be powered by 12 Vdc, 220 Wp (Isc = 10 mA) PV module with panel generation factor of 3.8 and 6 days of autonomy. Apply general assumption elsewhere.

3. a) What are the two main ways of generating energy from the sun? Differentiate between those two technologies. 03+04

   b) Define active and passive solar thermal systems with example. 06

   c) Describe following solar thermal systems: 12
   i) Solar thermal chimneys
   ii) Thermal energy storage systems

4. a) Define wind energy and wind turbine. List down the main components of a wind turbine. 04+05

   b) Classify wind turbine in terms of drag and lift of wind energy. 06

   c) Derive the available power equation of a wind turbine. 10

5. a) What is the difference between a windmill and wind turbine? 04

   b) Explain tip speed ratio of a wind turbine. Draw a typical C_p vs. λ curve of a wind turbine and state its significance. 04+05

   c) Given the following wind turbine data, calculate the available and maximum power from wind energy: 12
      i) Blade length = 25 meter,
      ii) Wind speed = 12 m/sec,
      iii) Air density = 1.23 kg/ m^3 and
      iv) Power Coefficient = 0.3.

6. a) Define following terms in regards to a wind energy system: 09
      i) Betz limit
      ii) Wind farm
      iii) Wind turbine class

   b) Define fuel cell and point out its key components with a figure. 06

   c) What are the different types of fuel cell? 05

   d) Write down the advantages of fuel cell technology. 05

7. a) State the key features of a fuel cell. 10

   b) Describe following types of fuel cell based on their key features: 15
      i) Molten carbonate fuel cell
      ii) Proton exchange membrane fuel cell
      iii) Alkali fuel cell

8. a) Define following terms: 10
      i) Primary and secondary battery
      ii) Dry cell
      iii) Dead battery
      iv) C rate of a battery
      v) Zinc carbonate battery

   b) Describe the operation of a typical battery with figure. 06

   c) State the function of a separator and casing in a battery. 04

   d) What is the criteria for choosing between a series or parallel connection of batteries? 05

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 6403 — Time: 3 Hours
Course Title: Wireless Communication — 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) Draw the network architecture for LTE and explain the functions of its components. 10

   b) Define radio frame, subframe, slot and resource block (RB) for LTE. 8

   c) Compare circuit switching and packet switching in terms of their advantages and disadvantages. 7

2. a) Why does a PDCCH signaling, on a particular subframe, allocates resources for uplink transmission on a later subframe? Mention why the UE cannot prepare the transport block before its allocation. 10

   b) What is the advantage of correlation in frequency domain compared to correlation in time domain during downlink synchronization? Mention the location of Primary Synchronization Signal (PSS) and Secondary Synchronization Signal (SSS) in time and frequency. Explain how different types of information are determined using Primary Synchronization Signal (PSS) and using Secondary Synchronization Signal (SSS). 15

3. a) Explain the step 1/2/3 search procedure for UMTS. 15

   b) What does the UE perform after powering up and before synchronization? 5

   c) What is the purpose of PCFICH? 5

4. a) How many Physical Cell Identity (PCI) are available in LTE? What would be the problem if a much higher or much lower number was used? 8

   b) Mention the purposes of location area (LA). Explain how the UE can determine that a Location Area Update (LAU) is required. 10

   c) Define virtual reality (VR) and augmented reality (AR). 7

5. a) What are the names of Machine-Type Communications (MTC) in Release 13, 14 and 15? What are the usual major differences in requirements between supporting M2M communication and H2H communication? How have these requirements been addressed with new UE categories in Release 13 and Release 14? In the early days of LTE, which UE category was used for M2M devices? 15

   b) What are the advantages and disadvantages of long discontinuous reception (DRX) cycle? Briefly explain how extended discontinuous reception (eDRX) and power saving mode (PSM) save power. How long can be the maximum sleep time for PSM? 10

6. a) Explain why semi-persistent scheduling is used and how it is used. Also, mention which applications are suitable for it. 10

   b) Compare Sigfox and NB-IoT in terms of current and future share in the market. 7

   c) A UE is 3 km away from eNodeB. Determine the value of timing offset. 8

7. a) Show that the minimum required value of Eb/No is – 1.6 dB for data transfer with negligible error. 10

   b) What is the bandwidth for NB-IoT? 5

   c) The received signal power is 200 mW and the total noise power is 2 mW. The operating bandwidth is equal to the total bandwidth of 2.4 GHz ISM band. Determine the theoretical maximum possible data rate with arbitrarily small error probability or negligible error. 10

8. a) Explain how timing alignment is maintained during uplink data transfer. How can the uplink synchronization be lost? Why is the maximum value of timing offset on the Timing Advance Command of MAC RAR is set to 0.67 ms? 10

   b) What is the maximum possible frequency to update the transmit power level in UMTS and in LTE? 6

   c) Why are dummy packets sent during voice communication in 2G or 3G? What information does the UE read when it wakes up during idle mode? 9

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M.Sc. Engg.(EE)/Ph.D. (EE)/M.Sc. TE 1st Sem. Date: 16 May, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 6411 — Time: 3 Hours
Course Title: Wireless Ad Hoc and Sensor Networks — 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. Symbols preserve their usual meanings.

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1. a) As a network designer, why do you need protocol suite? Why is protocol suite important for interoperability among different networks components? 4

   b) Write the name of layers of OSI model and briefly explain the responsible job done by each layer and how do they contribute to the whole network. What is the basic difference between OSI model and TCP/IP model? Briefly explain by comparing the layers of both models with suitable tabular forms. 13

   c) You want to send a packet of length 1,000 bytes from IUT. How long does it take to propagate over a link of distance 2,500 km, propagation speed 2.5×10^8 m/s and transmission rate of 2 Mbps? More generally, how long does it take for a packet of length L to propagate over a link of distance d, propagation speed s and transmission rate R bps? Does this delay depend on packet length? Does this delay depend on transmission rate? 8

2. a) As a Network Engineer, to build a real-world practical product, you need to follow four steps. 15
   Step1: Finding problem and define expected solution and hypothesis,
   Step2: Create Mathematical Model,
   Step3: Create Simulation Model,
   Step4: Create Practical Product.
   Briefly explain each step with suitable examples (use any network engineering problem as a case study such as underwater sensor network, vehicular network, internet of things, etc).

   b) For data communication in 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: 10

3. a) What do you mean by on-demand or reactive routing of Ad-hoc network? Explain Ad Hoc On-demand Distant Vector (AODV) and Dynamic Source Routing (DSR). 12

   b) What is hierarchical routing in Ad-hoc network? Explain ClusterHead Gateway Switch Routing (CGSR). 8

   c) Discuss and compare the performance of above three routings of Ad-hoc network, i.e., AODV, DSR and CGSR. 5

4. a) What is Wireless Sensor Networks (WSN)? 18
Explain three major roles of sensor nodes in WSN those act as Sources, Sinks and Actuators?
How WSN helps to build networks in following scenarios:
i) Disaster relief operations,
ii) Biodiversity mapping,
iii) Intelligent buildings (or bridges),
iv) Facility management,
v) Machine surveillance and preventive maintenance,
vi) Precision agriculture,
vii) Medicine and health care,
viii) Logistics and
ix) Telematics (vehicular technologies for road transportation, road safety)?
Explain with suitable illustrations.

b) What is Mobile Ad Hoc Networks (MANET)? What are the main differences between MANET and WSN? Briefly explain the differences with proper justification. 7

5. a) What is Delay Tolerant Networks (DTN)? What are the limitations associated with Internet caused by current TCP/IP model? How does DTN overcome those problems? Explain the followings characteristics of DTN: 10
i) Store-carry-forward,
ii) Custody transfer and
iii) Bundle layer.

b) How DTN helps to build networks in following scenarios: 15
i) Connecting the infrastructure-less rural areas and
ii) Underwater communication.
Explain the socio-economic aspect of these networks with suitable illustrations.

6. a) What do you understand by Ad-hoc networking? 6
Why is such networking required when there are standard networks?
What is self-organize characteristics in Ad-hoc networks?

b) What is vehicular Ad-hoc networking (VANET)? 13
Suppose there are two sink nodes located at Dhaka and Chittagong. How can you create networks to exchange data between these two sink nodes with the help of vehicular Ad-hoc networking (VANET) and wireless connectivity enabled devices? Explain and justify your techniques.

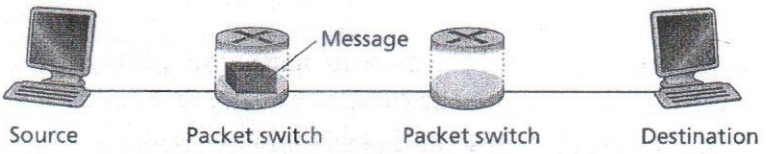
c) Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links of rates $R_1 = 500$ kbps, $R_2 = 2$ Mbps and $R_3 = 1$ Mbps. 6
i) Assuming no other traffic in the network, what is the throughput for the file transfer?
ii) Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?
Repeat (i) and (ii), but now with R_2 reduced to 100 kbps.

7. a) According to the IEEE standard, following wireless technologies are widely used according to the application categories: (802.21), (802.22), (802.11), (802.15.1), (802.16e), (2G, 3G), (802.20), (802.15.3), (802.16), (802.15.4). 12
Write down their names according to the applications and classify them according to the Area Network (AN). Also, for the above standards, draw the comparison graph for Range vs Data Rate (for 0.01 Mbps to 1000 Mbps).

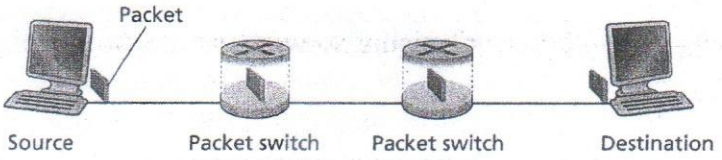
b) In modern packet-switched networks, including the Internet, following the message segmentation mechanism the source host segments long, application-layer messages (for example, an image or a music file) into smaller packets and sends the packets into the network. The receiver then reassembles the packets back into the original message. 13
Figure 7. (b) illustrates the end-to-end transport of a message with and without message segmentation. Consider a message that is 8×10^6 bits long is to be sent from source to destination. Suppose each link in the figure is 2 Mbps. Ignore propagation, queuing, and processing delays.

i) Consider sending the message from source to destination *without* message segmentation. How long does it take to move the message from the source host to the first packet switch? Keeping in mind that each switch uses store-and-forward packet switching, what is the total time to move the message from source host to destination host?

ii) Now suppose that the message is segmented into 800 packets, with each packet being 10,000 bits long. How long does it take to move the first packet from source host to the first switch? When the first packet is being sent from the first switch to the second switch, the second packet is being sent from the source host to the first switch. At what time will the second packet be fully received at the first switch? How long does it take to move the file from source host to destination host when message segmentation is used? Compare this result with your answer in part (i) and comment.



End-to-end message transport: without message segmentation



End-to-end message transport: with message

Figure 7. (b)

8. a) Explain Internet of Energy (IoE) and Energy Network considering the Internet of Things (IoT), smart demand side management of energy and consumers involvement through smart devices. 12
Explain and justify with suitable illustrations.

b) How would you explain Internet and Cloud Computing to a 6-years-old kid? 2

c) Briefly explain with example that *"Cloud Computing is the transformation of IT from a product to a service"*. 5

d) A communication expert observe that data continues to grow and application are becoming data intensive. Why do you think that data is important for the upcoming technological world? Briefly explain your answer with suitable examples. 6

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

Date: May 27, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: EEE 6601
Course Title: Antennas and Propagation

Winter Semester, A.Y. 2018-2019
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. Symbols carry their usual meanings.

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1. a) Define: Radiation resistance, directivity, antenna bandwidth. Draw an antenna equivalent circuit. What is the main difference between the antenna equivalent circuit and an RLC circuit? 15

   b) Design a log-periodic antenna to obtain a gain of 9 dB and to operate over a frequency range of 125 MHz-500 MHz. 10

2. a) Find out the relationship between W_T and W_R. Draw the radiation patterns of dipole for dipole length = $\lambda/2$, λ, and 2λ. 15

   b) Find the basic and actual transmission losses between two antennas separated by 30 m operating at 10 MHz when the gain of each antenna is 1.65 dB. 10

3. a) What are the typical shapes of patch antenna? What are the methods of controlling the bandwidth of a patch antenna? Write the expressions for calculating intrinsic impedance, directivity, effective height and conductance of patch antenna. 15

   b) For a double stub matching network, calculate the length of two stub with characteristic impedance of 50 Ω and transmission line is terminated with load 100 + j100 Ω. The first stub is placed 0.4λ away from load and spacing between two stubs is $3\lambda/8$. 10

4. a) Draw the geometry of a folded dipole antenna and hence show that its impedance is 292 Ω. 15

   b) If a helical antenna has a spacing between turns 0.05 m, diameter 0.1 m, number of turns equal to 20 and operates at 1000 MHz, find the Null to Null beamwidth of the main beam and also half-power beamwidth and directivity. 10

5. a) What are the advantages of array antenna? Derive the expression for resultant radiation pattern of two-element array. 15

   b) A uniform linear array is required to produce an end-fire beam when it is operated at a frequency of 10 GHz. It contains 50 radiators which are spaced at 0.5λ. Find the array length. 10

6. a) Discuss the gain measurement by two and three antenna methods. 15

   b) A circular loop antenna has a diameter of 1.5λ. Find its directivity and radiation resistance. 10

7. a) What is radio horizon? Derive an equation for calculating the radio horizon distance between transmitting and receiving antennas. 15

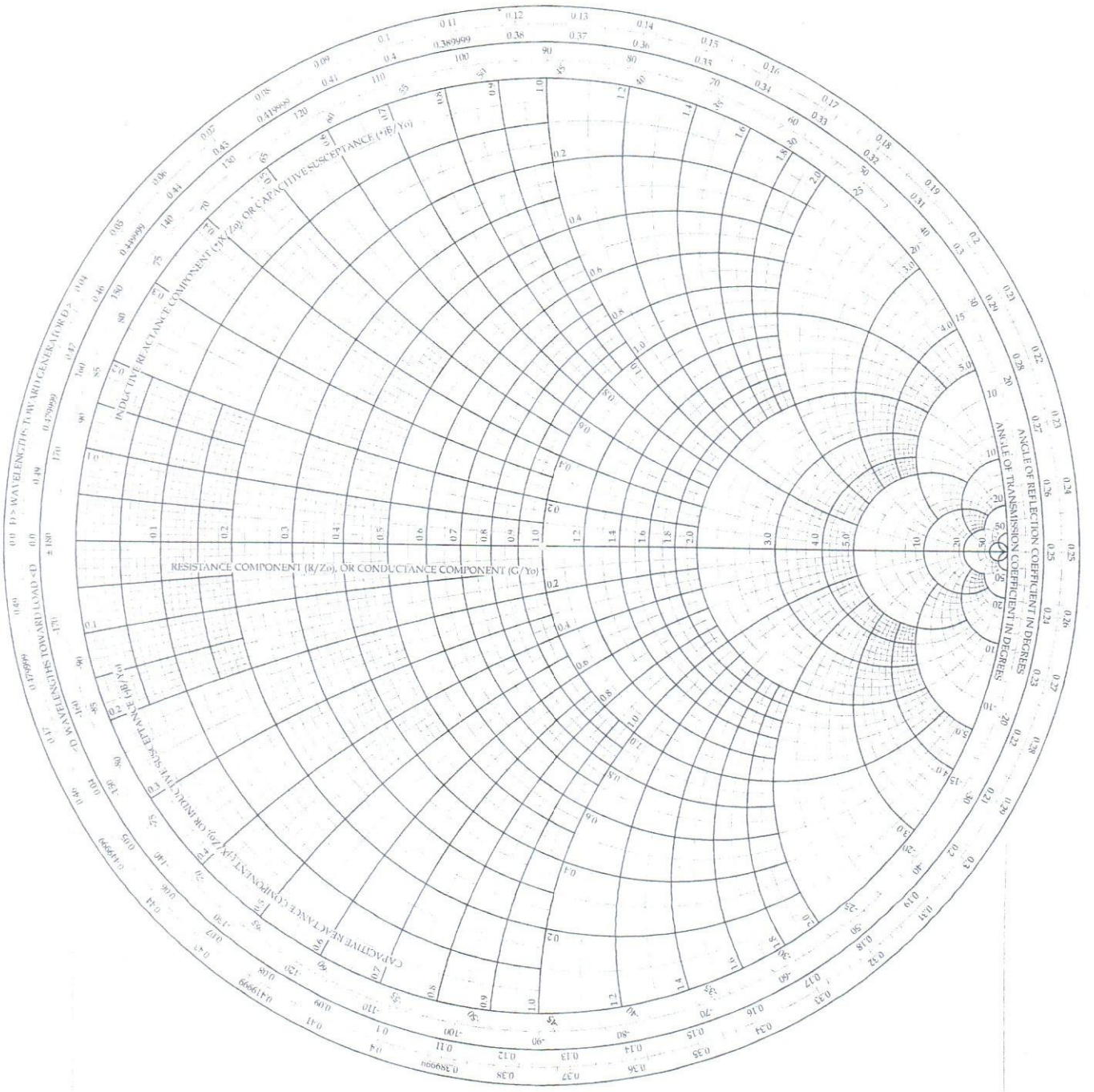
b) A communication system is to be established at a frequency of 60 MHz with a transmitted power of 1 kW. The field strength of the directive antenna is 3 times than that of a half wave antenna. $h_t = 50$ m, $h_r = 5$ m. A field strength of 80 μV/m is required to give satisfactory reception. Find the range of the system. 10

8. Write short notes on: (any four) 25

i) isotropic radiators,
ii) folded dipole antennas,
iii) omni-directional antennas,
iv) antenna aperture efficiency and
v) duct propagation.

IMPEDANCE SMITH CHART

Introduction to RF Circuit Design



RADIALLY SCALED PARAMETERS

M.Sc. Engg.(EE)/PhD(EE) Date: May 29, 2019(Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 6607 — Time: 3 Hours
Course Title: Computational Electromagnetics — 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) Why are analytical methods not adequate in solving real world electromagnetic (EM) problems? Mention some commonly used numerical techniques in EM. What are the possible sources of error in numerical techniques? 10

b) The potential distribution of the rectangular region with boundaries indicated in Fig. 1(b) is obtained by solving Laplace equation analytically as, 15

$$V(x,y)=\frac{4V_0}{\pi}\sum_{1,odd}^{\infty}\frac{1}{m}\frac{\sinh(m\pi x/b)}{\sinh(m\pi d/b)}\sin\left(\frac{m\pi y}{b}\right).$$

Use this equation to find $V(0.5,0.5)$ for m=1, 3 and 5. Compare this value with numerically obtained ones using finite difference(FD) scheme. Use $\Delta x=\Delta y=0.25$. All dimensions are in cm.

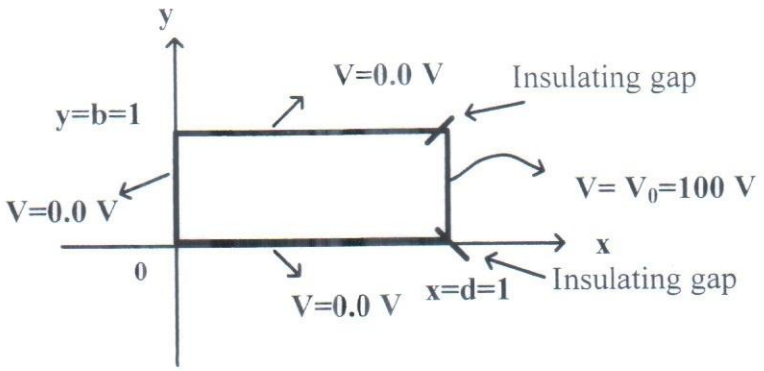

Fig. 1(b)

2. a) If a uniform charge density $\rho_s=5.0\mu C/cm^2$ exists in the rectangular region of Fig. 1(b), what modification in the FD scheme is needed to find the potential distribution $V(x,y)$ in the region. Show three iterations with step size mentioned in Fig. 1(b). 12

b) Nodes 2, 0 and 4 are on the interface between two media with dielectric constants shown in Fig. 2(b). Modify the FD scheme to find the potential at node 0. 13

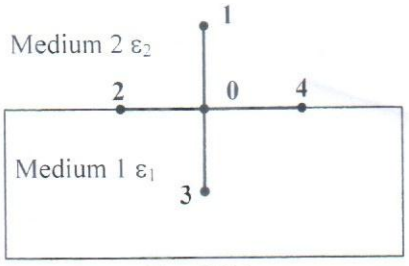

Fig. 2(b)

220

3 Derive the explicit FD scheme for the parabolic PDE $\frac{\partial \varphi}{\partial t} = \frac{1}{k}\frac{\partial^2 \varphi}{\partial x^2}$, using central difference formula. Show that scheme is conditionally stable. How can this scheme be made unconditionally stable by Crank and Nicholson algorithm? From the computational point of view mention the relative advantages and disadvantages of the schemes. 25

4. a) The FD approximation of the one-dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ can be written as, $u^{n+1} \cong (c\Delta t)^2 \left[\frac{u_{i+1}^n - 2u_i^n + u_{i-1}^n}{(\Delta x)^2}\right] + 2u_i^n - 2u_i^{n-1}$. Obtain the numerical dispersion relation considering the complex-valued wavenumber, $\tilde{k} = \tilde{k}_{real} + j\tilde{k}_{img}$, where u is discretely sampled in space and time at (x_i, t_n) and expressed as, $u_i^n = e^{j(\omega n\Delta t - \tilde{k} i\Delta x)}$. 12

b) Using equation derived in (a) investigate the following three cases; 13

Case 1: $\Delta x \to 0$ and $\Delta t \to 0$,

Case 2: $c\Delta t = \Delta x$,

and Case 3: $c\Delta t = 0.5\Delta x$ and $\Delta x = 0.1\lambda_0$.

Where λ_0, is the free space wavelength of the EM wave and c is the velocity of EM wave.

5. a) What are the characteristics of finite difference time domain(FDTD) algorithm proposed by Yee for solving Maxwell's equation? 10

b) Derive the FDTD update equation of Electric Field and Magnetic Field for two dimensional TM mode of Maxwell's equations employing Yee's grid cell. You may consider the source-free version of the Maxwell's equation. 15

6. a) Describe the method of solving EM boundary value problem using the method of weighted residuals. 10

b) Find the approximate solution of the simple boundary value problem, 15

$$\frac{d^2\phi}{dx^2} - \phi = -x, \quad 0<x<1$$

with homogeneous boundary conditions ϕ=0 at x=0 and x=1, determine the coefficient of the trail function $\tilde{\phi}(x) = a_1 x(1-x) + a_2 x^2(1-x)$ using (i) collocation method (x=1/3 and x=2/3 as collocation points) and (ii) Galerkin's method. Compare the results at the midpoint with the exact value 0.0566.

7 a) Two parallel plates with surface charge distribution are shown in Fig. 6(a). The lower and upper plates are maintained at potential $-V_0$ and V_0, respectively. Derive the general matrix equation for the charge densities using the method of moments. 13

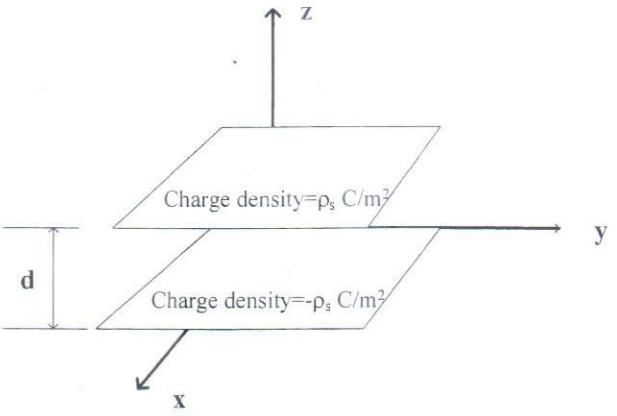

Fig. 6(a)

b) Using the distributed model of a transmission line(TL), derive the TL model for elliptic, parabolic and hyperbolic type EM problems. 12

8. a) Derive the equations for the element shape functions for triangular elements and hence identify the desirable properties of an element shape function. 12

b) The coordinate values of a triangular element are given in the table below, determine the element coefficient matrix. 13

Node	x	y
1	4.0	2.0
2	7.0	2.0
3	7.0	6.0

PhD/ M.Sc. Engg. (EE)/ M.Sc.TE May 21, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 6705/EEE 6195 — Time: 3 Hours
Course Title: Digital Control System — 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. Use suitable assumptions for missing information.

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1. a) Define Sampling Theorem. With suitable diagram explain the sampling theorem. 09

   b) Explain mathematically why ideal low pass filter is not physically not realizable. Show how the frequency response of the zero-order hold resembles a low pass filter. 09

   c) Briefly explain folding, aliasing and hidden oscillation. 07

2. a) What is the significance of pulse transfer function in digital control system design? 3

   b) Obtain the pulse transfer function of the system shown in Fig. 2(b), where G(s) is given by, 7

$$G(s)=\frac{1-e^{-Ts}}{s}\frac{1}{s(s+1)}$$

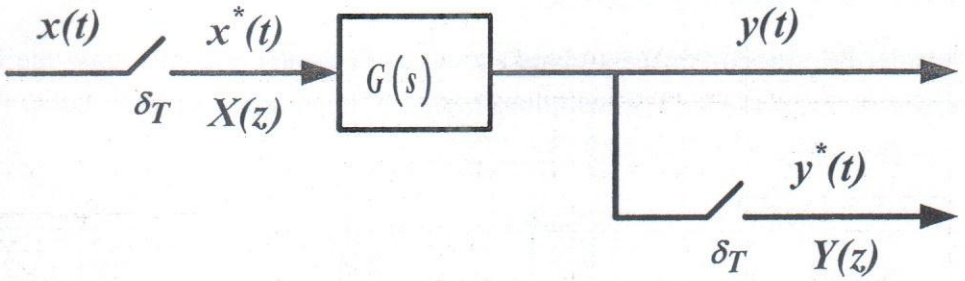


Fig. 2(b)

Note that, there is a sampler at the input of G(s).

   c) Obtain the pulse transfer function of a digital PID controller. 15

3. a) Consider a digital filter defined by, 10

$$G(z)=\frac{Y(z)}{X(z)}=\frac{4(z-1)\left(z^2+1.2z+1\right)}{(z+0.1)\left(z^2-0.3z+0.8\right)}$$

Draw a series realization and a parallel realization diagram. (use one first order section and one second order section)

   b) Obtain the block diagrams for the following pulse transfer function system (a digital filter) by (i) direct programming, (ii) standard programming, and (iii) ladder programming. 15

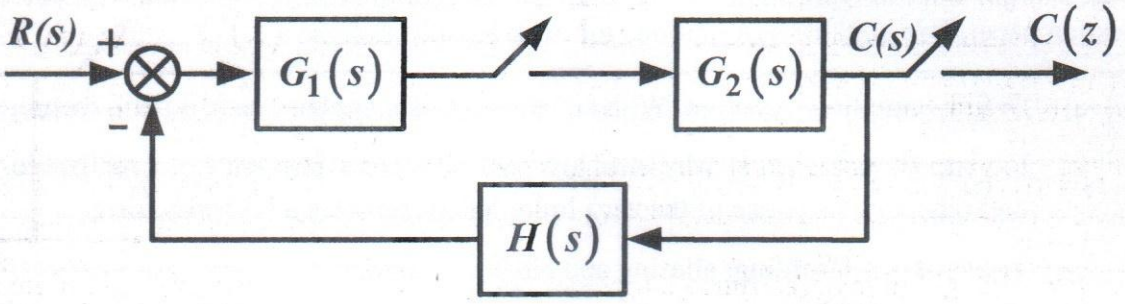
$$G(z)=\frac{Y(z)}{X(z)}=\frac{2-0.6z^{-1}}{1+0.5z^{-1}}$$

4. a) What is Infinite and Finite-impulse response filter? Explain how a finite-impulse response filter can be realized. 8

b) The digital filter of the following is a recursive filter. Modify this digital filter and realize it as a non-recursive filter. Then obtain the response of this non-recursive filter to a Kronecker delta input. 10

$$G(z)=\frac{Y(z)}{X(z)}=\frac{2-0.6z^{-1}}{1+0.5z^{-1}}$$

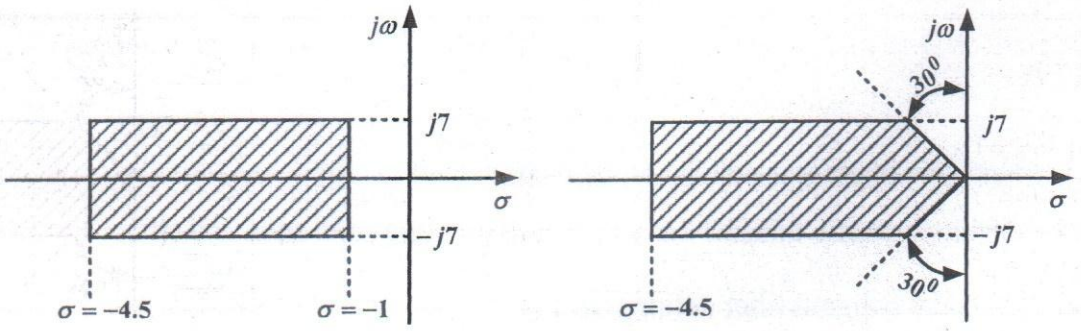
c) Derive the pulse transfer function of the following closed-loop discrete-time control system. 07



5. a) Explain how the left half of the s-plane is mapped into the z-plane 08

b) With suitable diagram show the following region in s-plane and corresponding z-plane. 08
(i) Constant-Attenuation Loci
(ii) Settling time
(iii) Constant-Frequency Loci
(iv) Constant Damping Ratio Loci

c) Consider the regions in the s-plane shown in Fig (c)(i) and (ii), draw the corresponding regions in the z-plane. The sampling period T is assumed to be 0.3 sec. (The sampling frequency is $\omega_S = 2\pi/T = 2\pi/0.3 = 20.9$ rad/sec.) 09



(i) (ii)

Fig. 5(c)

6. a) Examine the stability of the following characteristic equation using Jury stability test: 10

$$P(z)=z^4-1.2z^3+0.07z^2+0.3z-0.08=0$$

b) Consider the discrete-time unit-feedback control system (with sampling period T = 1 sec) whose open-loop pulse transfer function is given by, 15

$$G(z)=\frac{K(0.3679z+0.2642)}{(z-0.3679)(z-1)}$$

Determine the range of gain K for stability by use of Jury stability test.

7. a) Discuss how root locus method differs from continuous-time domain analysis to discrete time domain analysis. 5

b) Consider the digital control system shown in Fig. 7(b). In the z-plane, design a digital controller such that the dominant closed-loop poles have a damping ratio ζ of 0.5 and a settling time of 2 sec. The sampling period is assumed to be 0.2 sec, or T = 0.2. Also obtain the static velocity error constant K_V of the system 20

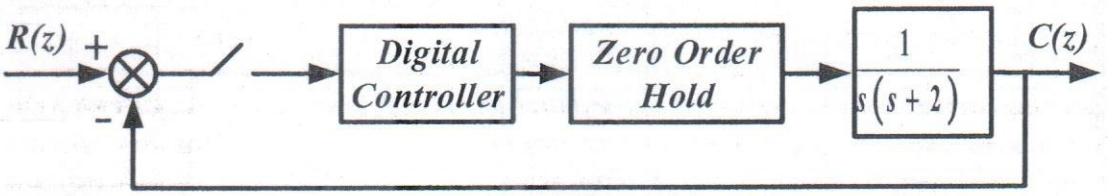


Fig. 7(b)

8. a) Discuss, what measure is necessary to carry out frequency response analysis for discrete-time control system. 5

b) Consider the digital control system in Fig. 8(b), where the plant transfer function is $1/s^2$. Design a digital controller in the w-plane such that the phase margin is 500 and the gain margin is at least 10 dB. The sampling period is 0.1 sec, or T = 0.1. After designing the controller, obtain static velocity error constant K_v. 20

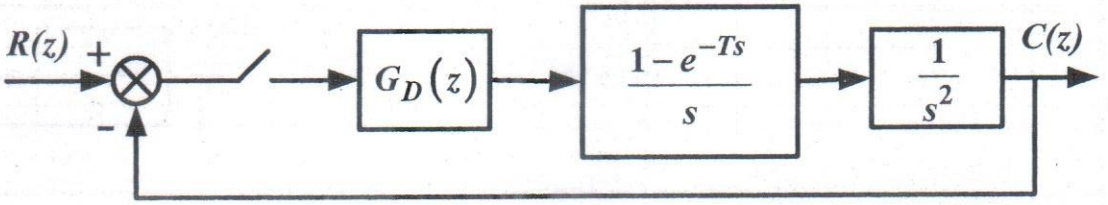


Fig. 8(b)

Table 2-1: Table of z Transform

	$X(s)$	$x(t)$	$x(kT)$ or $x(k)$	$X(z)$
1.	-	-	Kronecker delta $\delta_o(k)$ $1,\ k=0$ $0,\ k\neq 0$	1
2.	-	-	$\delta_o(n-k)$ $1,\ n=k$ $0,\ n\neq k$	z^{-k}
3.	$\frac{1}{s}$	$1(t)$	$1(k)$	$\frac{1}{1-z^{-1}}$
4.	$\frac{1}{s+a}$	e^{-at}	e^{-akt}	$\frac{1}{1-e^{-aT}z^{-1}}$
5.	$\frac{1}{s^2}$	t	kT	$\frac{Tz^{-1}}{\left(1-z^{-1}\right)^2}$
6.	$\frac{2}{s^3}$	t^2	$(kT)^2$	$\frac{T^2z^{-1}\left(1+z^{-1}\right)}{\left(1-z^{-1}\right)^3}$
7.	$\frac{6}{s^4}$	t^3	$(kT)^3$	$\frac{T^3z^{-1}\left(1+4z^{-1}+z^{-2}\right)}{\left(1-z^{-1}\right)^4}$
8.	$\frac{a}{s(s+a)}$	$1-e^{-at}$	$1-e^{-akt}$	$\frac{\left(1-e^{-aT}\right)z^{-1}}{\left(1-z^{-1}\right)\left(1-e^{-aT}z^{-1}\right)}$
9.	$\frac{b-a}{(s+a)(s+b)}$	$e^{-at}-e^{-bt}$	$e^{-akt}-e^{-bkt}$	$\frac{\left(e^{-aT}-e^{-bT}\right)z^{-1}}{\left(1-e^{-aT}z^{-1}\right)\left(1-e^{-bT}z^{-1}\right)}$
10.	$\frac{1}{(s+a)^2}$	te^{-at}	kTe^{-akt}	$\frac{Te^{-aT}z^{-1}}{\left(1-e^{-aT}z^{-1}\right)^2}$
11.	$\frac{s}{(s+a)^2}$	$(1-at)e^{-at}$	$(1-akt)e^{-akt}$	$\frac{1-(1+aT)e^{-aT}z^{-1}}{\left(1-e^{-aT}z^{-1}\right)^2}$
12.	$\frac{2}{(s+a)^3}$	t^2e^{-at}	$(kT)^2e^{-akt}$	$\frac{T^2e^{-aT}\left(1+e^{-aT}z^{-1}\right)z^{-1}}{\left(1-e^{-aT}z^{-1}\right)^3}$
13.	$\frac{a^2}{s^2(s+a)}$	$at-1+e^{-at}$	$akt-1+e^{-akt}$	$\frac{\left[\left(at-1+e^{-aT}\right)+\left(1-e^{-aT}-aTe^{-aT}\right)z^{-1}\right]z^{-1}}{\left(1-z^{-1}\right)^2\left(1-e^{-aT}z^{-1}\right)}$
14.	$\frac{\omega}{s^2+\omega^2}$	$\sin\omega t$	$\sin\omega kT$	$\frac{z^{-1}\sin\omega T}{1-2z^{-1}\cos\omega T+z^{-2}}$

15.	$\frac{s}{s^2+\omega^2}$	$\cos \omega t$	$\cos \omega kT$	$\frac{1-z^{-1}\cos \omega T}{1-2z^{-1}\cos \omega T+z^{-2}}$
16.	$\frac{\omega}{(s+a)^2+\omega^2}$	$e^{-at}\sin \omega t$	$e^{-akT}\sin \omega kT$	$\frac{e^{-aT}z^{-1}\sin \omega T}{1-2e^{-aT}z^{-1}\cos \omega T+e^{-2aT}z^{-2}}$
17.	$\frac{s}{(s+a)^2+\omega^2}$	$e^{-at}\cos \omega t$	$e^{-akT}\cos \omega kT$	$\frac{1-e^{-aT}z^{-1}\cos \omega T}{1-2e^{-aT}z^{-1}\cos \omega T+e^{-2aT}z^{-2}}$
18.			a^k	$\frac{1}{1-az^{-1}}$
19.			a^{k-1} $k=1,2,3,\ldots$	$\frac{z^{-1}}{1-az^{-1}}$
20.			ka^{k-1}	$\frac{z^{-1}}{(1-az^{-1})^2}$
21.			k^2a^{k-1}	$\frac{z^{-1}(1+az^{-1})}{(1-az^{-1})^3}$
22.			k^3a^{k-1}	$\frac{z^{-1}(1+4az^{-1}+a^2z^{-2})}{(1-az^{-1})^4}$
23.			k^4a^{k-1}	$\frac{z^{-1}(1+11az^{-1}+11a^2z^{-2}+a^3z^{-3})}{(1-az^{-1})^5}$
24.			$a^k\cos k\pi$	$\frac{1}{1+az^{-1}}$
25.			$\frac{k(k-1)}{2!}$	$\frac{z^{-2}}{(1-z^{-1})^3}$
26.		$\frac{k(k-1)\ldots(k-m+2)}{(m-1)!}$		$\frac{z^{-m+1}}{(1-z^{-1})^m}$
27.			$\frac{k(k-1)}{2!}a^{k-2}$	$\frac{z^{-2}}{(1-az^{-1})^3}$
28.		$\frac{k(k-1)\ldots(k-m+2)}{(m-1)!}a^{k-m+1}$		$\frac{z^{-m+1}}{(1-az^{-1})^m}$

Table 2.2: Important Properties and Theorems of the z Transform

	$x(t)$ or $x(k)$	$Z[x(t)]$ or $Z[x(k)]$
1.	$ax(t)$	$aX(z)$
2.	$ax_1(t)+bx_2(t)$	$aX_1(z)+bX_2(z)$
3.	$x(t+T)$ or $x(k+1)$	$zX(z)-zx(0)$
4.	$x(t+2T)$	$z^2X(z)-z^2x(0)-zx(T)$
5.	$x(k+2)$	$z^2X(z)-z^2x(0)-zx(1)$
6.	$x(t+kT)$	$z^kX(z)-z^kx(0)-z^{k-1}x(T)-\ldots-zx(kT-T)$
7.	$x(t-kT)$	$z^{-k}X(z)$
8.	$x(n+k)$	$z^kX(z)-z^kx(0)-z^{k-1}x(T)-\ldots-zx(k-1)$
9.	$x(n-k)$	$z^{-k}X(z)$
10.	$tx(t)$	$-Tz\frac{d}{dz}X(z)$
11.	$kx(k)$	$-z\frac{d}{dz}X(z)$
12.	$e^{-at}x(t)$	$X(ze^{aT})$
13.	$e^{-ak}x(k)$	$X(ze^{a})$
14.	$a^kx(k)$	$X\left(\frac{z}{a}\right)$
15.	$ka^kx(k)$	$-z\frac{d}{dz}X\left(\frac{z}{a}\right)$
16.	$x(0)$	$\lim_{z\to\infty}X(z)$ if the limit exists
17.	$x(\infty)$	$\lim_{z\to1}\left[\left(1-z^{-1}\right)X(z)\right]$ if $\left(1-z^{-1}\right)X(z)$ is analytic on and outside the unit circle
18.	$\nabla x(k)=x(k)-x(k-1)$	$\left(1-z^{-1}\right)X(z)$
19.	$\Delta x(k)=x(k+1)-x(k)$	$(z-1)X(z)-zx(0)$
20.	$\sum_{k=0}^{n}x(k)$	$\frac{1}{1-z^{-1}}X(z)$
21.	$\frac{\partial}{\partial a}x(t,a)$	$\frac{\partial}{\partial a}x(z,a)$
22.	$k^mx(k)$	$\left(-z\frac{d}{dz}\right)^mX(z)$
23.	$\sum_{k=0}^{n}x(kT)y(nT-kT)$	$X(z)Y(z)$
24.	$\sum_{k=0}^{\infty}x(k)$	$X(1)$