Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term (Regular) Examination, 2018
Department of Electrical and Electronic Engineering
EE 2209
Electronics-II

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.
(iii) Necessary graphs may be supplied on request.

Section A

Q1. (a) Define transistor hybrid model. Deduce the expression of current gain, voltage gain, input impedance, and output impedance of a transistor amplifier in terms of h-parameters. (12)
(b) Draw the hybrid π-model at low frequencies and find $r_{bb'}$, r_{ce}, and $r_{b'e}$ in terms of h-parameters. (10)
(c) Calculate overall voltage gain of the following amplifier circuit using hybrid model. (13)

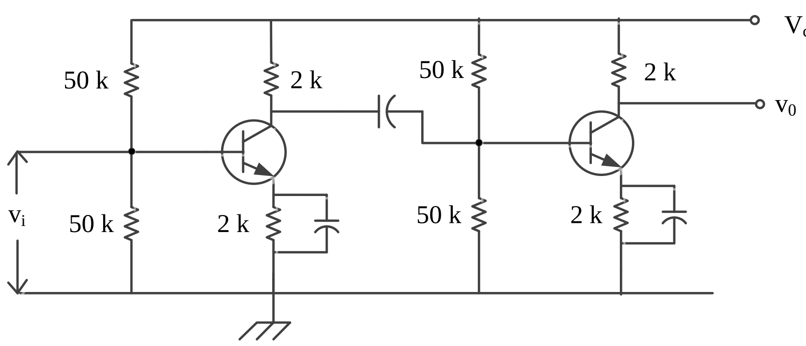

Fig. Q1(c)

Q2. (a) Mention minimum five differences between power and voltage amplifiers. (05)
(b) "In power amplifiers transformer coupling is invariably used." —Explain it with a numerical example. (12)
(c) Show that the maximum efficiency of a class B power amplifier is 78.54%. (08)
(d) For the power amplifier shown in Fig. 2(d), calculate input power, output power, efficiency, and power handled by each transistor. (10)

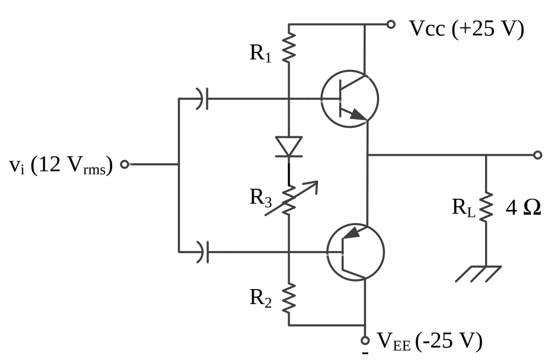

Fig. Q2(d)

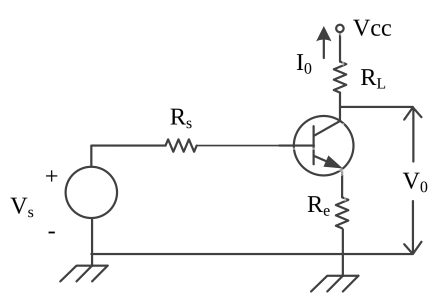

Fig. Q4(c)

Q3. (a) How can you generate push-pull signals? What do you mean by quasi-complementary circuit in power amplifiers? (10)
(b) What are the total harmonic and crossover distortion in power amplifiers? Calculate the THD and total power for a harmonic distortion reading of $D_2 = 0.1$, $D_3 = 0.02$ and $D_4 = 0.01$ with $I_1 = 4$ A and $R_c = 8\ \Omega$. (08)
(c) Discuss the effect of bypass capacitor connected across the emitter at low frequencies. (12)
(d) Draw the Giacoletto model of BJT at HF. (05)

Q4. (a) In the study of feedback amplifiers, classify amplifiers and relate them with different types of feedback amplifiers. (10)
(b) Suppose that you need increased input resistance for a specific purpose. How can you achieve it by incorporating feedback in amplifiers? (12)
(c) Mention the type of feedback of the circuit shown in Fig. 4(c). If $G_{mf} = -1$ mA/V, $A_{vf} = -4$, $D = 50$, $R_s = 1$ kΩ, and $h_{fe} = 150$, calculate (i) R_e, (ii) R_L, and (iii) R_{if}. Neglect the value of $r_{bb'}$. (13)

Section B

Q5.
(a) "FET is a voltage-controlled device."— Explain. (09)
(b) Sketch the construction and explain the basic principle of operation of p-channel depletion type MOSFET. Also, draw the characteristics and transfer curve of this MOSFET. Indicate the mode of operations on the transfer curve. (15)
(c) What is meant by CMOS? Show that CMOS can be used as an inverter. State some extensive applications of CMOS. (11)

Q6.
(a) Draw the five types of JFET biasing configurations and their ac-equivalent circuits. (15)
(b) For the n-channel depletion type MOSFET shown in Fig. 6(b), draw the transfer curve and the load line. From these, determine I_{DQ}, V_{GSQ}, and V_{DS}. (12)

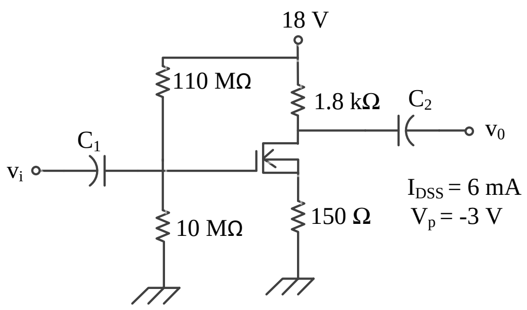

Fig. Q6(b)

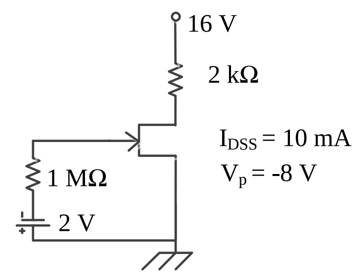

Fig. Q6(c)

(c) Calculate (i)V_{GSQ}, (ii) I_{DQ}, (iii) V_{DS} for the JFET shown in Fig. 6(c). (08)

Q7.
(a) For the following circuit in Fig. 7(a) draw the ac equivalent circuit and obtain the expression of Z_i, Z_0, and A_v if (i) $r_d < 10R_D$, (ii) $r_d \geq 10R_D$, where the symbols have their usual meaning. (10)

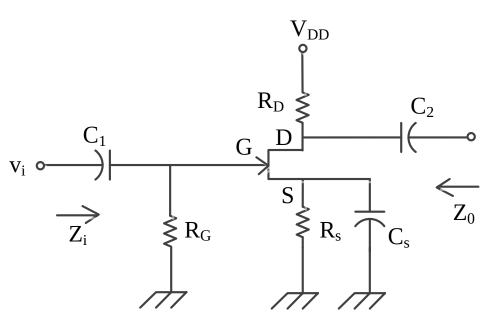

Fig. Q7(a)

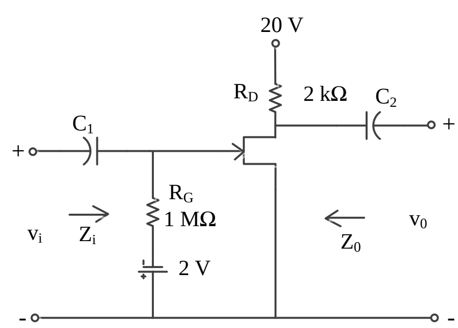

Fig. Q7(b)

(b) The circuit shown in Fig. 7(b) has an operating point defined by V_{GSQ} = -2V and I_{DQ} = 5.625 mA, with I_{DSS} = 10 mA and V_p = -8V. The value of y_{os} is 40 μs. Determine the value of (i) g_m, (ii) Z_i,(iii) Z_0, (iv) A_V, and (v) A_V ignoring effect of r_d. (10)
(c) Differentiate between ideal and typical values of input resistance, output resistance, and open-loop gain of an op-amp. Design an op-amp having two inputs both at inverting and non-inverting terminals V_1 and V_2, respectively that will give an output $V_0 = V_2 - V_1$. (15)

Q8.
(a) Mention the three basic differences between active and passive filters. Define slew rate. Derive the expression of maximum frequency to operate an op-amp. (08)
(b) Design an active low pass filter with a dc gain of 5 and a corner frequency of 500 Hz. (07)
(c) Design an analog computer to solve the following differential equation using minimum number of op-amp. (13)

$$5 \iint v_0 dt^2 + \frac{d^2 v_0}{dt^2} + 2\frac{dv_o}{dt} + v_o = 10 \sin 4t, \ t > 0.$$

(d) Calculate the output voltage of the following amplifier. (07)

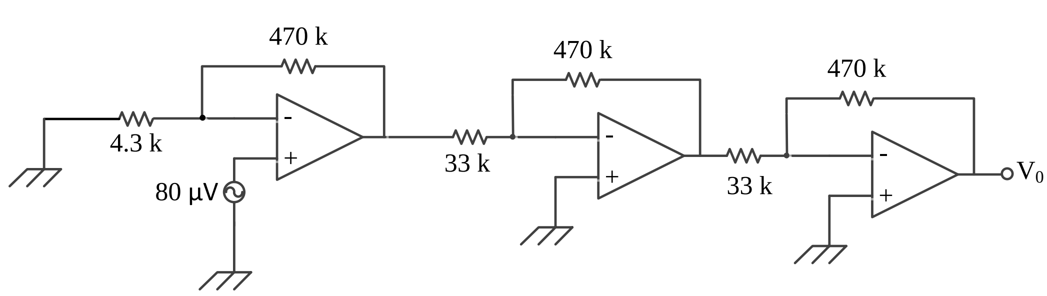

Fig. Q8(d)

Khulna University of Engineering & Technology

B. Sc. Engineering 2nd Year 2nd Term (Regular) Examination, 2018

Department of Electrical and Electronic Engineering

EE 2211

Electromagnetic Field

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) State and explain Coulomb's law. From the law, define electric field intensity. Calculate the electric field at points on an axis for a ring of positive charge. (13)

(b) Write Gauss's law and prove that the law for an arbitrary closed surface. Define homogeneous, isotropic, linear and time invariant materials. (13)

(c) What is electric dipole? Define dipole moment and find the equation for dipole potential. (09)

Q2. (a) Define electrostatic potential and find the potential of a uniform distribution of charge having spherical symmetry. (11)

(b) Show that $c = \epsilon A/d$ and $\bar{E} = -\text{grad}\,\varphi$ where the symbols have their usual meanings. Find the equation of electric field of a dipole using spherical co-ordinates. (14)

(c) Derive the boundary conditions in electrostatics. Draw necessary diagram showing two different media. (10)

Q3. (a) Show that energy stored in an electrostatic field is $W_E = \frac{1}{2}\int_{vol} \epsilon_o\, E^2 dv$; where the symbols have their usual meanings. (13)

(b) Derive Laplace's and Poisson's equations. (10)

(c) Solve Laplace's equation for the equipotential field in the homogeneous region between two concentric conducting spheres with radii a and $b,\ b > a,$ if $V = 0$ at $r = b$ and $V = V_0$ at $r = a,$ find the capacitance between them. (12)

Q4. (a) Define magnetic flux density and magnetic field intensity. Find field on the axis of a circular loop using Ampere's law. (08)

(b) Write Ampere's circuital law and find magnetic field (i) about a line current (ii) between co-axial cylinders and (iii) inside a uniform current. (09)

(c) What is vector magnetic potential? Derive the equations for vector magnetic potentials and magnetic fields of a parallel wire transmission line. (10)

(d) State Stokes theorem and demonstrate it. (08)

Section B

Q5. (a) State Maxwell's equation in differential and integral form. Also, write Maxwell's equation for time harmonic field. (10)

(b) The cylindrical shell, 1 cm $< \rho <$ 1.2 cm, is composed of conducting material for which $\sigma = 10^6$ S/m. The external and internal regions are non-conducting. Let $H_\varphi = 2000$ A/m at $\rho = 1.2$ cm. Find $\overline{\text{H}}$ & $\overline{\text{E}}$ everywhere. (13)

(c) The electric field intensity in the region $0 < x < 5,\ 0 < y < {}^{\pi}/_{12},\ 0 < z < 0.06\ m$ in free space is given by $\bar{E} = C\, \sin 12y\, \sin az\, \cos 2 \times 10^{10} t\, \overline{a_x}\ V/m$. Begining with the $\nabla \times \overline{\text{E}}$ relationship, use Maxwell's equation to find a numerical value for a, if it is known that a is greater than zero. (12)

Q6.	(a)	Derive the equation for the velocity of a uniform plane wave propagating in a lossy dielectric.	(12)
	(b)	Determine the phase difference between electric field and magnetic field of a uniform plane wave propagating in a conducting medium. Also, determine the UPW is propagating in a lossless dielectric.	(13)
	(c)	(i) A microwave oven operates at 2.45 GHz. Assume that $\sigma = 1.2 \times 10^6 S/m$ and $\mu_R = 500$ for the stainless steel interior, find the depth of penetration (ii) Let $\overline{E_S} = 50\angle 0^\circ\ V/m$ at the surface of the conductor and plot a curve of the amplitude of E_S vs the angle of E_S as the field propagates into the stainless steel.	(10)
Q7.	(a)	Define polarization. Explain linear and elliptical polarization with appropriate field orientation diagram.	(10)
	(b)	Derive the equation of reflection co-efficient and transmission co-efficient for obliquely.	(11)
	(c)	Write down the properties of a uniform plane wave.	(05)
	(d)	Briefly describe the terms (i) Maximum usable Frequency, (ii) Skip distance and (iii) Virtual Height.	(09)
Q8.	(a)	Prove that if a TEM wave is partially reflected from an interface then both travelling wave and standing wave exist in the first medium. Also, find the position of maximum electric & magnetic fields.	(13)
	(b)	A 150 MHz uniform plane wave is normally incident from air onto a material whose intrinsic impedance is unknown. Measurements yield a standing wave ratio of 3 and the appearance of an electric field minimum at 0.3 wavelengths in front of the interface. Determine the impedance of the unknown material.	(10)
	(c)	A right-circularly polarized plane wave in air is incident at Brewster's angle onto a semi-infinite slab of plexiglass ($\epsilon_R' = 3.45, \quad \epsilon_R'' = 0$) (i) Determine the fractions of the incident power that are reflected and transmitted. (ii) Describe the polarization of the reflected and transmitted waves.	(12)

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EE 2235

Signals and Systems

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.

(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Define a signal mathematically with examples. Briefly explain different types of elementary signals with examples. (10)

(b) Find the even and odd components of the wave shown in Fig. Q1(b). (07)

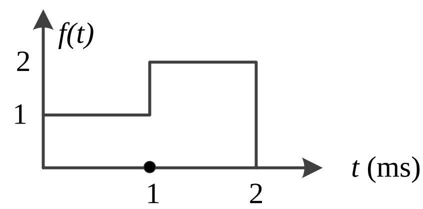

Fig. for Q1(b)

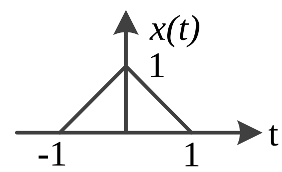

Fig. for Q1(d)

(c) Determine the fundamental period of the following signals, if they are periodic. (10)
(i) $x[n] = \cos(2\pi n)$ (ii) $x(t) = X_m \sin(100\pi t)$.

(d) A triangular pulse is shown in Fig. Q1(d). Sketch the signal $x(3t-2) + x(3t+2)$ from the signal $x(t)$. (08)

Q2. (a) How can you represent a signal by using impulse functions? Explain mathematically. (08)

(b) Find the general solution of the following RL circuit as depicted in Fig. Q2(b), where $x(t) = V \sin wt$. (15)

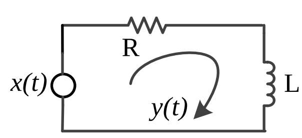

Fig. for Q2(b)

(c) Explain the term: state, state vector, and state space. Derive the state equation and output equation from the circuit shown in Fig. Q2(c). (12)

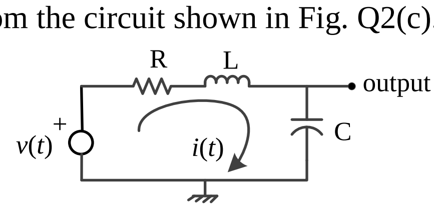

Fig. for Q2(c)

Q3. (a) Find the equations that describe the motion of the mechanical system shown in Fig. Q3(a). Also draw its $f-v$ and $f-i$ analogous electrical circuits. (20)

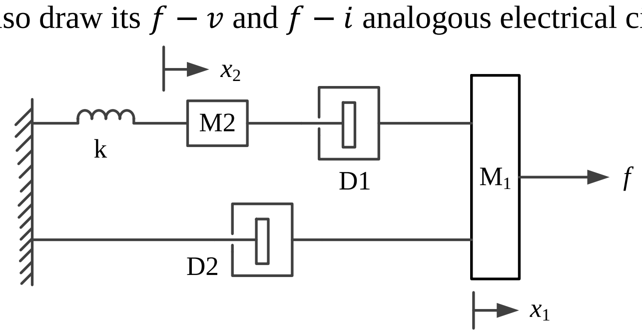

Fig. for Q3(a)

(b) For the following mechanical system, determine the transfer function using electrical quantities. (15)

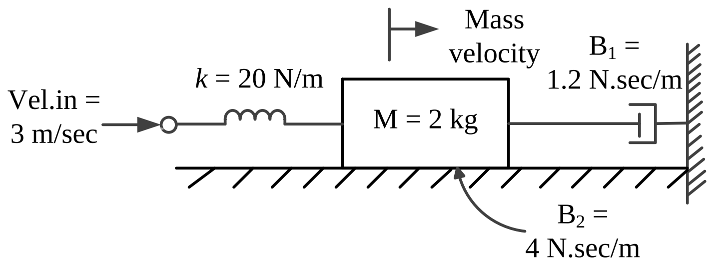

Fig. for Q3(b)

Q4. (a) What is the difference between Fourier series and Fourier transform? What are the applications of them? (08)

(b) Find the Fourier series expansion and sketch the frequency spectrum of the following periodic waveform, where $f(\theta) = 10\sin\theta + 3\sin 3\theta$. (15)

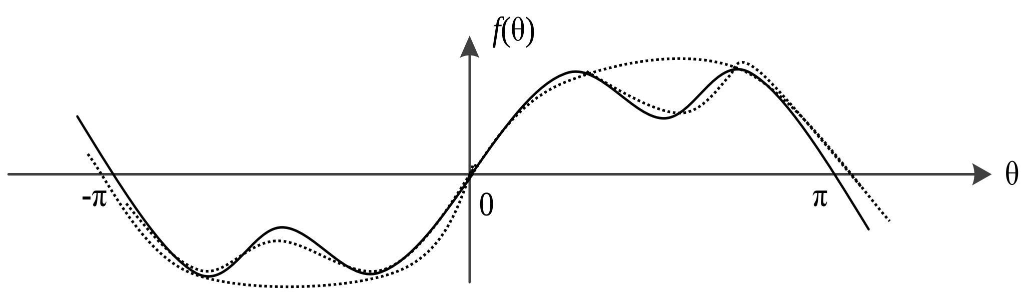

Fig. for Q4(b)

(c) Determine the Fourier transform for the following waveshape shown in Fig. Q4(c) and also sketch its relative frequency distribution. (12)

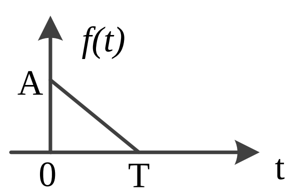

Fig. for Q4(c)

Section B

Q5. (a) Define gate function. What is the utility of gate function? Plot the following sinusoidal functions approximately to scale and also find their Laplace transform. (15)

(i) $\cos\omega(t - t_0)$ (ii) $\cos\omega(t - t_0)\,u(t)$

(iii) $\cos\omega t\,u(t - t_0)$ (iv) $\cos\omega(t - t_0)\,u(t - t_0)$.

(b) Find the Laplace transform of the rectangular wave shown in Fig. Q5(b). (10)

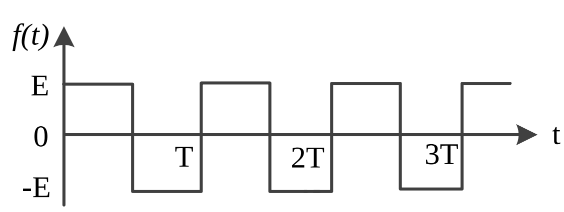

Fig. Q5(b)

(c) Find $L\,[t\cos^2 3t]$ and $L\left[\frac{1}{t}\,(1 - e^{-\alpha t})\right]$. (10)

Q6.	(a)	Find the inverse Laplace transform of the following functions: (i) $F(s) = \frac{s+2}{s(s^2-1)}$ (ii) $F(s) = \frac{1-e^{-4s}}{3s^3+2s^2}$ (iii) $F(s) = \frac{1}{\sqrt{s^2+a^2}}$.	(18)
	(b)	State and proof the impedance concept for a series R-L-C circuit by determining its response to periodic sinusoidal excitation.	(17)
Q7.	(a)	It is found that when a d-c voltage of 10 volts is applied to the input terminals of an initially relaxed network at $t = 0$ the output voltage is $5e^{-t/2}$ volts. Determine the output voltage response of two such networks in cascade when an exponential voltage $v_i(t) = 20e^{-3t/2}\, v(t)$ volts is applied at the input.	(15)
	(b)	The switch in the circuit of Fig. Q7(b) is closed at $t = 0$. The desired response is the current i_2 in R_2. Find i_2 by using both the convolution integral and the superposition integral.	(20)

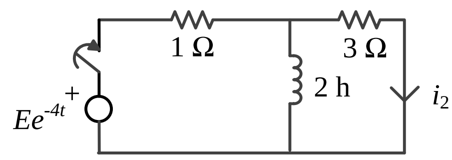

Fig. Q7(b)

Q8.	(a)	If $Z[f(t)] = F(z)$, then proof $$Z[f(t-nT)\, v(t-nT)] = Z^{-n}F(z).$$	(07)
	(b)	Find $Z[tC^{\alpha t}]$.	(05)
	(c)	Find $Z^{-1}[\frac{5Tz}{(z+2)(z-1)^2} - \frac{z}{z+2}]$.	(08)
	(d)	Twenty-one 5 Ω resistors are connected to a d-c voltage source of 20 volts in a ladder arrangement as shown in Fig. Q8(d). Determine the current in the last resistor, R_{21}.	(15)

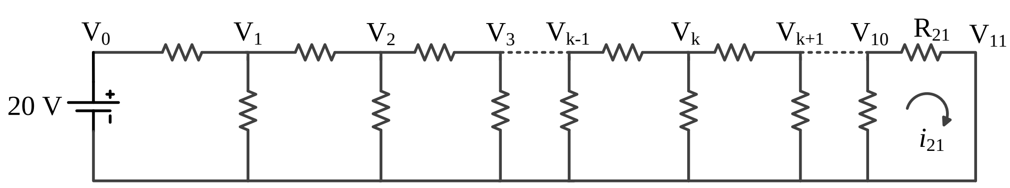

Fig. Q8(d)

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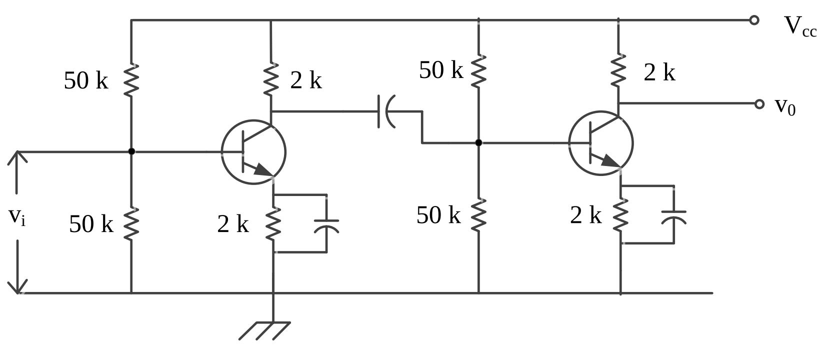

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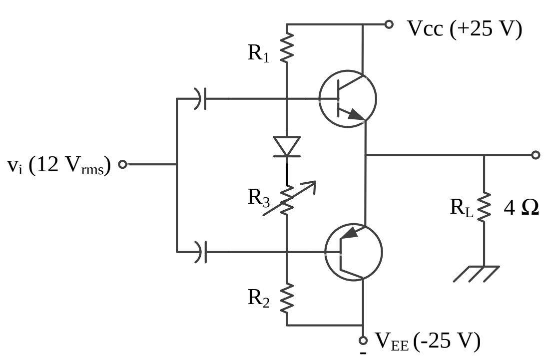
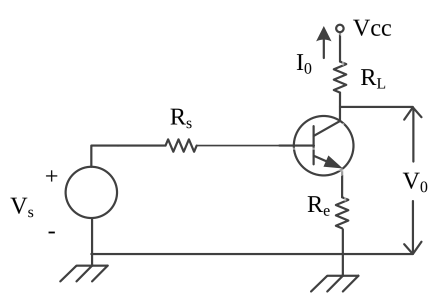


Fig. Q2(d)



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Section B

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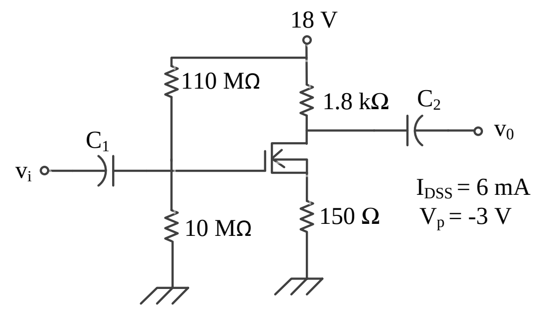

Fig. Q6(b)

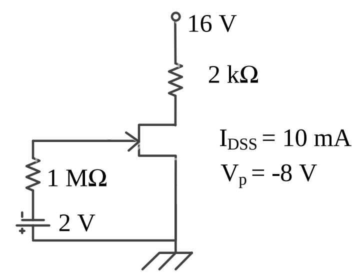

Fig. Q6(c)

(c) Calculate (i)V_{GSQ}, (ii) I_{DQ}, (iii) V_{DS} for the JFET shown in Fig. 6(c). (08)

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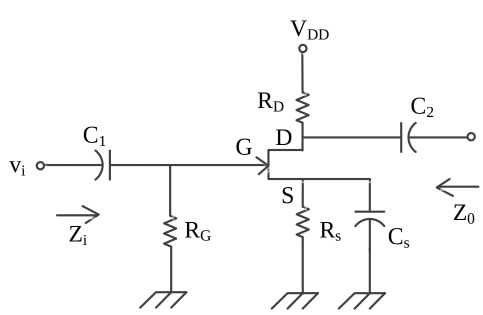
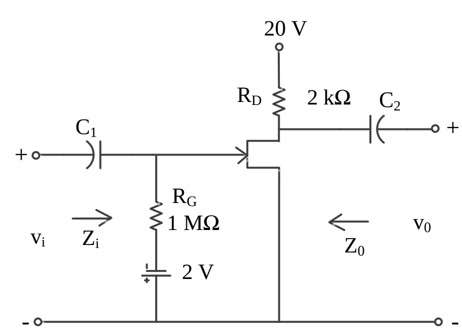


Fig. Q7(a)



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(b) Design an active low pass filter with a dc gain of 5 and a corner frequency of 500 Hz. (07)

(c) Design an analog computer to solve the following differential equation using minimum number of op-amp. (13)

$5 \iint v_0 dt^2 + \frac{d^2 v_0}{dt^2} + 2\frac{dv_o}{dt} + v_o = 10 \sin 4t,\ t > 0.$

(d) Calculate the output voltage of the following amplifier. (07)

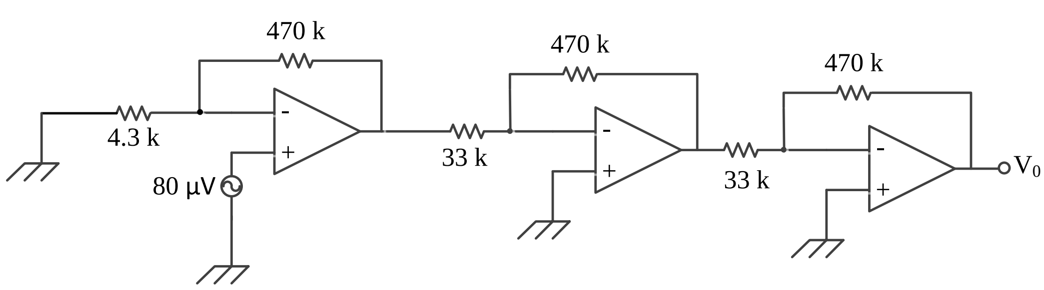

Fig. Q8(d)

Khulna University of Engineering & Technology

B. Sc. Engineering 2nd Year 2nd Term (Regular) Examination, 2018

Department of Electrical and Electronic Engineering

EE 2211

Electromagnetic Field

Time: 3 hours | Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) State and explain Coulomb's law. From the law, define electric field intensity. Calculate the electric field at points on an axis for a ring of positive charge. (13)

(b) Write Gauss's law and prove that the law for an arbitrary closed surface. Define homogeneous, isotropic, linear and time invariant materials. (13)

(c) What is electric dipole? Define dipole moment and find the equation for dipole potential. (09)

Q2. (a) Define electrostatic potential and find the potential of a uniform distribution of charge having spherical symmetry. (11)

(b) Show that $c = \epsilon A/d$ and $\bar{E} = -\text{grad}\, \varphi$ where the symbols have their usual meanings. Find the equation of electric field of a dipole using spherical co-ordinates. (14)

(c) Derive the boundary conditions in electrostatics. Draw necessary diagram showing two different media. (10)

Q3. (a) Show that energy stored in an electrostatic field is $W_E = \frac{1}{2}\int_{vol} \epsilon_o\, E^2 dv$; where the symbols have their usual meanings. (13)

(b) Derive Laplace's and Poisson's equations. (10)

(c) Solve Laplace's equation for the equipotential field in the homogeneous region between two concentric conducting spheres with radii a and $b,\ b > a,$ if $V = 0$ at $r = b$ and $V = V_0$ at $r = a,$ find the capacitance between them. (12)

Q4. (a) Define magnetic flux density and magnetic field intensity. Find field on the axis of a circular loop using Ampere's law. (08)

(b) Write Ampere's circuital law and find magnetic field (i) about a line current (ii) between co-axial cylinders and (iii) inside a uniform current. (09)

(c) What is vector magnetic potential? Derive the equations for vector magnetic potentials and magnetic fields of a parallel wire transmission line. (10)

(d) State Stokes theorem and demonstrate it. (08)

Section B

Q5. (a) State Maxwell's equation in differential and integral form. Also, write Maxwell's equation for time harmonic field. (10)

(b) The cylindrical shell, 1 cm $< \rho <$ 1.2 cm, is composed of conducting material for which $\sigma = 10^6$ S/m. The external and internal regions are non-conducting. Let $H_\varphi = 2000$ A/m at $\rho = 1.2$ cm. Find $\overline{\text{H}}$ & $\overline{\text{E}}$ everywhere. (13)

(c) The electric field intensity in the region $0 < x < 5,\ 0 < y < {}^{\pi}/_{12},$ $0 < z < 0.06\ m$ in free space is given by $\bar{E} = C\ \sin 12y\ \sin az\ \cos 2 \times 10^{10} t\ \overline{a_x}\ V/m$. Begining with the $\nabla \times \overline{\text{E}}$ relationship, use Maxwell's equation to find a numerical value for a, if it is known that a is greater than zero. (12)

Q6.	(a)	Derive the equation for the velocity of a uniform plane wave propagating in a lossy dielectric.	(12)
	(b)	Determine the phase difference between electric field and magnetic field of a uniform plane wave propagating in a conducting medium. Also, determine the UPW is propagating in a lossless dielectric.	(13)
	(c)	(i) A microwave oven operates at 2.45 GHz. Assume that $\sigma = 1.2 \times 10^6 S/m$ and $\mu_R = 500$ for the stainless steel interior, find the depth of penetration (ii) Let $\overline{E_S} = 50 \angle 0^\circ \; V/m$ at the surface of the conductor and plot a curve of the amplitude of E_S vs the angle of E_S as the field propagates into the stainless steel.	(10)
Q7.	(a)	Define polarization. Explain linear and elliptical polarization with appropriate field orientation diagram.	(10)
	(b)	Derive the equation of reflection co-efficient and transmission co-efficient for obliquely.	(11)
	(c)	Write down the properties of a uniform plane wave.	(05)
	(d)	Briefly describe the terms (i) Maximum usable Frequency, (ii) Skip distance and (iii) Virtual Height.	(09)
Q8.	(a)	Prove that if a TEM wave is partially reflected from an interface then both travelling wave and standing wave exist in the first medium. Also, find the position of maximum electric & magnetic fields.	(13)
	(b)	A 150 MHz uniform plane wave is normally incident from air onto a material whose intrinsic impedance is unknown. Measurements yield a standing wave ratio of 3 and the appearance of an electric field minimum at 0.3 wavelengths in front of the interface. Determine the impedance of the unknown material.	(10)
	(c)	A right-circularly polarized plane wave in air is incident at Brewster's angle onto a semi-infinite slab of plexiglass ($\epsilon_R' = 3.45, \quad \epsilon_R'' = 0$) (i) Determine the fractions of the incident power that are reflected and transmitted. (ii) Describe the polarization of the reflected and transmitted waves.	(12)

Khulna University of Engineering & Technology

B. Sc. Engineering 2nd Year 2nd Term (Regular) Examination, 2018

Department of Electrical and Electronic Engineering

Hum 2217

Professional Ethics and Moral Thoughts

Time: 3 hours | Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Define 'Ethics and Professional Ethics'. Explain the meaning of Ethics from different viewpoints. 'Ethics is the science of ultimate good'—explain. (15)

(b) Explain the psychological basis of Ethics. (10)

(c) What is the fundamental moral concept in ethics—the right or the good? Discuss. (10)

Q2. (a) What is egoism? Discuss the different types of egoism. (10)

(b) How is character formed? Explain relation between character and conduct. (10)

(c) Give your own opinion on the following: (10)
Can one and the same action be both right and wrong either at the same time or at different time?

(d) Define and explain 'Relativitism'. (05)

Q3. (a) What is moral responsibility? Find out the relation between moral responsibility and free will. (15)

(b) "Morality is indispensable to religion." Discuss. (10)

(c) Comment on the following: (10)
The question whether an action is right or wrong always depends on its actual consequences.

Q4. (a) What is moral judgement? What are the objects of moral judgement? (10)

(b) What are the postulates of morality? Are we free to choose an act? Discuss. (15)

(c) Whom do you judge first, ourselves or others? Fully discuss the question. (10)

Section B

Q5. (a) Where and how does Professional Ethics fit in engineering? What are the factors influence engineering decision? Explain the reasonings of engineering viewpoints. (13)

(b) Define a profession. Describe the characteristics that are responsible for converting an occupation to a profession. Is engineering a profession? Justify. (10)

(c) Describe the IEEE fundamental codes of Ethics. (12)

Q6. (a) What do you mean by utilitarianism? Critically examine the moral ideal of the "greatest happiness of the greatest number". (12)

(b) 'During the past few decades the professional ethics for engineers is focused on its negative face'—discuss. Also, discuss that there are aspirations too. Give examples of both the causes. (13)

(c) Define facts and common ground. Explain the three approaches of respect for persons. (10)

Q7. (a) Show the differences between morality and ethics. Explain the relations of Honesty, Courage and Sharing with professional ethics. (08)

(b) What is Empathy? Describe the challenges in work place. Discuss on the methods to overcome the challenges. (10)

(c) What is moral dilemma? Describe the steps to resolve moral dilemma. Describe the theories of moral development. (09)

(d) Explain responsibility, liability, duty and rights in profession. (08)

Q8. (a) Explain the procedure of assessing safety and risk. Discuss the risk-benefit analysis. (10)

(b) Write down the global engineering problems. (07)

(c) Dutta is in the second year of his first full-time job offer graduation in engineering. He enjoys design, but he is becoming increasingly concerned by more experienced engineers. He has been assigned to assist in the design of a number of projects that involve public safety, such as schools and overhead walk ways between buildings. He spoke to his supervisor, whose engineering competence he respects, and the supervisor told that more experienced engineer checked his work. Later, he discovers that his work is often not checked. Instead, his drawings are stamped and passed on to the contractor. Some of the smaller projects he designs are under construction within a few weeks after the designs are completed. (18)

At this point, Dutta calls one of his professors in Engineering college for advice. "I am really scared that I am going to make a mistake that will kill someone," Dutta says. "I try to over-design, but the projects that I have been assigned to, are becoming increasingly difficult. What should I do?" Dutta's Professor tell him that be connect ethically continue on his present course, for his work surpasses, his qualifications and may endanger the public. What should Dutta do?

Khulna University of Engineering & Technology

B. Sc. Engineering 2nd Year 2nd Term (Regular) Examination, 2018

Department of Electrical and Electronic Engineering

Math 2203

Mathematics-IV

Time: 3 hours | Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.

(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Determine the set of points and sketch them in the argand diagram represent by $|z+i|+|z-i| \leq 3$. (09)

(b) If z_1, z_2 and z_3 are three complex numbers, show that $|z_1 z_2 z_3| = |z_1||z_2||z_3|$ and $amp\{z_1 z_2 z_3\} = amp\{z_1\} + amp\{z_2\} + amp\{z_3\}$. (10)

(c) Prove that $\underset{z \to -1+i}{\text{Lt}} \frac{z^2 - z + 1 - i}{z^2 + 1} = 2$. (08)

(d) Locate and name the singularities of each of the following functions in the finite z-plane: (08)

(i) $\frac{\cos z}{(z+i)^3}$ (ii) $\frac{z^2 - 2iz - 1}{z^4 + 2z^2 + 1}$

Q2. (a) Verify whether the function $\text{u}(x, \text{y}) = \text{y}^2 - x^2 + 2\text{e}^{-x}\sin\text{y}$ is harmonic and, if so, find the corresponding analytic function $f(\text{z})$. Also hence find the harmonic conjugate of u. (14)

(b) Evaluate $\int_C (\bar{z} - z^2)dz$, where C is the upper-half of the circle $|z| = 1$ in the positive sense. (08)

(c) Find all the singularities of $\frac{\cot \text{Mz}}{(\text{z}-3)^2}$ and determine the residue(s) at the poles, if any. (13)

Q3. (a) Expand $f(z) = \frac{z-1}{z+1}$ in a Taylor series about $z = 0$. (09)

(b) If $F(z_0) = \oint_C \frac{2z^2 - z - 2}{z - z_0} dz$, where C is the circle $|z| = 3$ in the positive sense, find $F'(-2i)$ using suitable theorem. What will be the value of $F(4)$? (13)

(c) Evaluate $\int_0^\infty \frac{\sin x}{x} dx$ by using contour integration. (13)

Q4. (a) Expand $f(z) = \frac{z-1}{(z+1)(z-3)}$ in a Laurent's series valid for the region $0 < |z+1| < 4$. (09)

(b) Evaluate the integrals (i) $\int_0^{2\pi} \frac{d\theta}{5 + 3\cos 2\theta}$, (ii) $\int_0^\infty \frac{\cos 2x}{x^2 + 1} dx$ using the method of contour integration. (26)

Section B

Q5. (a) Find the Laplace transform of the rectangular wave of period $2a$ given by (10)

$$f(t) = \begin{cases} t, & 0 < t < a \\ 2a - t, & a < t < 2a. \end{cases}$$

(b) State convolution property of inverse Laplace transform and use it to evaluate $L^{-1}\left\{\frac{s^2}{(s^2 + a^2)(s^2 + b^2)}\right\}$. (12)

(c) An inductor of 2 henrys, a resistor of 8 ohms and a capacitor of 0.4 farads are connected in series with an e.m.f. of $2\sin t$ Volts. At t = 0 the charge on the capacitor and current in the circuit are zero. Find the charge and current at any time $t > 0$. (13)

Q6. (a) Find the series of sines and cosines of multiples of x which represents $f(x)$ in the interval $-\pi < x < \pi$, where $f(x) = \begin{cases} 0, & -\pi < x \le 0 \\ \frac{\pi x}{4}, & 0 < x < \pi. \end{cases}$ (18)

(b) Find the half-range cosine series of the function $f(x) = x,\ 0 < x < 2$ and hence write Parseval's identity corresponding to the series. (17)

Q7. (a) A sinusoidal voltage $E \sin wt$ is passed through a half-wave rectifier which clips the negative portion of the wave. Find the Fourier series of such periodic function $(t) = \begin{cases} 0, & -\frac{T}{2} < t < 0 \\ E\ \sin wt, & 0 < t < \frac{\pi}{2} \end{cases}$, where $T = \frac{2\pi}{\omega}$. (15)

(b) Find the Fourier integral of the function $F(x) = e^{-kx}$ when $x > 0$ and $f(-x) = f'(x)$ for $k > 0$ and hence prove that $\int_0^\infty \frac{\cos ux}{k^2 + u^2} du = \frac{\pi}{2k} e^{-kx}$. (10)

(c) Find the inverse Fourier sine transform of $f_s(n) = \frac{n}{1 + n^2}$. (10)

Q8. (a) Find the solution $U(x,t)$ of the boundary value problem $\frac{\partial U}{\partial t} = 3\frac{\partial^2 U}{\partial x^2}$ subject to the boundary conditions $U(0,t) = U(2,t) = 0,\ t > 0$ and the initial condition $U(x,0) = x, 0 < x < t$. (17)

(b) Solve the three-dimensional Laplace equation $\frac{\partial^2 U}{\partial x^2} + \frac{\partial^2 U}{\partial y^2} + \frac{\partial^2 U}{\partial z^2} = 0$ by the method of separation of variables. (18)