Date: 08.06.2026

Khulna University, Khulna
Second Year Term I Examination
Session: **2024-2025**
Electronics and Communication Engineering Discipline
Course No.: **ECE 2115**
Full Title of the Course: **Electrical Machine I**
Full Marks: **60** Time: **03** Hours

- The figure in the margin indicates full marks. The questions are of equal value.
- **Use separate sheet for each section.**

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1.(a) What do you mean by voltage transformation ratio of a transformer? From this voltage transformation ratio, discuss the construction of step up and step down transformer. 03

(b) Explain the working principle of a practical transforer under no load and load conditions. Also draw the detail vector diagram of a tranformer mentioning the loss parameters under resistive, inductive and capacitive load conditions. 03

(c) A single-phase transformer has 1000 turns on the primary and 200 turns on the secondary. The no load current is 3 amp. at a p.f. of 0.2 lagging. Calculate the primary current and power-factor when the secondary current is 280 Amp at a p.f. of 0.80 lagging. 04

2.(a) The following data refer to a I-phase transformer: 05
Turn ratio 19.5 : 1 ; $R_1 = 25\ \Omega$; $X_1 = 100\ \Omega$; $R_2 = 0.06\ \Omega$; $X_2 = 0.25\ \Omega$. No-load current $I_o = 1.25$ A leading the flux by 30°. The secondary delivers 200 A at a terminal voltage of 500 V and p.f. of 0.8 lagging. Determine by the aid of a vector diagram, the primary applied voltage, the primary p.f. and the efficiency.

(b) Draw the circuit diagram of open-circuit test and short-circuit test of a transformer. From these diagrams, how do you calculate the equivalent circuit parameters of a practical transformer? Also draw an equivalent circuit diagram of a transformer. 05

3.(a) Explain the working principle of Kapp regulation diagram of a transformer with the help of necessary figure. From this diagram how do you calculate percentage regulation 'down' of a transformer. 03

(b) In a 25-kVA, 2000/200 V, single-phase transformer, the iron and full-load copper losses are 350 W and 400 W respectively. Calculate the efficiency at unity power factor on 04
(i) full load (ii) half full-load.

(c) With the help of necessary figure, explain the working principle of an auto transformer. Also write some applications of auto transformer. 03

4.(a) A 5-kVA, 2,300/230-V, 50-Hz transformer was tested for the iron losses with normal excitation and Cu losses at full-load and these were found to be 40 W and 112 W respectively. Calculate the efficiencies of the transformer at 0.8 power factor for the following kVA outputs. Plot efficiency vs kVA output curve. 05

kVA outputs					
1.25	2.5	3.75	5.0	6.25	7.5

(b) A 100-kVA lighting transformer has a full-load loss of 3 kW, the losses being equally divided between iron and copper. During a day, the transformer operates on full-load for 3 hours, one half-load for 4 hours, the output being negligible for the remainder of the day. Calculate the all-day efficiency. 03

(c) What do you mean by current transformer and voltage transformer? 02

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5.(a) What is a Commutator? 02

(b) Describe the working mechanism of a Simple Loop Generator 04

(c) Define the following parameters: a) Armature core, b) Commutator Pitch, c) Pole Pitch, and d) Fractional Pitched Coil 04

6.(a) A 4-pole, DC machine has 144 slots in the armature with two coil-sides per slot, each coil has two turns. The flux per pole is 20 mWb, the armature is lap wound, and if it rotates at 720 rpm, what is the induced emf (i) across the armature (ii) across each parallel path? 04

(b) A DC generator has an induced voltage on open circuit of 127 V. When the machine is on load, the terminal voltage is 120 V. Find the load current if the field resistance is 15 Ω and the armature resistance is 0.02 Ω. Ignore armature resistance. 04

(c) What is armature reaction, and how does it affect the performance of a machine? 02

7.(a) Describe a Shunt generator. 03

(b) A shunt generator supplies 96 A at a terminal voltage of 200 volts. The armature and shunt field resistance are 0.1Ω and 50 Ω, respectively. The iron and friction losses are 2500W. Find, (i) emf generated, (ii) copper losses, and (iii) commercial efficiency. 04

7(c) Describe how to draw the no-load characteristics of a DC generator. 03

8.(a) Prove that the mechanical power developed by the motor is maximum when the back e.m.f is equal to half the applied voltage. 03

(b) A 230 V d..c. shunt motor takes 5 A at no-load and runs at 1000 $r.p.m$. Calculate the speed when loaded and taking a current of 30 A. The armature and field resistances are 0.2 Ω and 230 Ω, respectively. 04

(c) With the help of necessary equations, explain the generator action of motor and motor action of a generator. Also write down the significance of these actions. 03

Date: 10/06/2026

Khulna University, Khulna
Electronics and Communication Engineering Discipline
Second Year **First** Term Examination, Session: **2024-2025**
Course No.: **0541 09 Math 2271(R)**
Full Title of the Course: **Matrix and Complex Variable**
Credit Hours: **3.00** Full Marks: **60** Time: **03** Hours

- The figure in the margin indicates full marks. The questions are of equal value.
- **Use separate sheet for each section.**

SECTION A
There are **FOUR** questions in this section. Answer any **THREE** questions.

1(a) What is diagonalization of a matrix? Prove that every matrix satisfies its characteristic equation. [L1, CLO3] 05

1(b) Determine the values of λ so the linear system in x, y and z has i) a unique solution ii) more than one solution iii) no solution, [L5, CLO3] 05

$$x + y + z = 1$$
$$x + 2y + 4z = \lambda$$
$$x + 4y + 10z = \lambda^2$$

2(a) Define with examples (i) matrix. (ii) skew symmetric matrix (iii) Hermitian matrix (iv) orthogonal matrix (v) idempotent matrix. [L1, CLO2] 05

2(b) What do you mean by conjugate matrix and skew-Hermitain matrix? Find the inverse of the matrix with the help of augmented matrix. [L1, CLO1] 05

$$A = \begin{bmatrix} 2 & 1 & -3 \\ 2 & -5 & 0 \\ 6 & -1 & 4 \end{bmatrix}$$

3(a) Determine the rank of the matrix: $\begin{pmatrix} 1 & 2 & -3 & -2 \\ 1 & 3 & -2 & 0 \\ 3 & 8 & -7 & -2 \\ 2 & 1 & -9 & -10 \end{pmatrix}$. [L3, CLO3] 05

3(b) Find the base for the eigenspaces of the matrix $\begin{pmatrix} 0 & 0 & -2 \\ 1 & 2 & 1 \\ 1 & 0 & 3 \end{pmatrix}$. [L1, CLO3] 05

4(a) What is binary operation? Write the properties of a set of vectors to be a vector space on $\mathbb{R}^3$. [L1, CLO2] 05

4(b) Test the set of vectors $\{(2,1,4),(1,-1,3),(3,2,5)\}$ for linear dependence on $\mathbb{R}^3$. [L4, CLO1] 05

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5(a) Describe complex number, complex plane, modulus of a complex number, amplitude and polar form of a complex number. [L2, CLO4] 05

5(b) If z_1 and z_2 be complex numbers then prove that 05

$(i)\,|z_1+z_2| \le |z_1|+|z_2|$ and $(ii)\,|z_1-z_2| \le |z_1|-|z_2|$ [L3, CLO4]

6(a) State and derive the Cauchy-Riemann equations in polar form. [L4, CLO4] 05

6(b) Construct a harmonic conjugate function $\phi(x,y)$ such that $\phi + i\psi$ is an analytic function where $\psi(x,y) = ln[(x-1)^2 + (y-2)^2]$, and formulate the corresponding complex function $f(z) = \phi + i\psi$ explicitly in terms of the complex variable z. [L2, CLO5] 05

7(a) Derive a generalized version of Cauchy's integral formula. [L3, CLO5] 05

7(b) Evaluate $\int_c \bar{z}dz$ from z = 0 to $z = 4+2i$ along the c given by [L5, CLO5] 05

(i) $z = t^2 + it$

(ii) the line from $z = 0$ to $z = 2i$ and the line from $z = 2i$ to $z = 4+2i$

8(a) Evaluate $\oint_C \frac{e^z dz}{(z^2+\pi^2)^2}$, where C is the circle $|z| = 4$. [L5, CLO6] 05

8(b) Determine the Laurent series about the indicated singularity of the function $\frac{z}{(z+1)(z+2)}; z = -2$. [L5, CLO6] 05

Date: 11-06-2026

Khulna University, Khulna

Electronics and Communication Engineering Discipline

Second Year, **First** Term **Examination**

Session: 2024-2025

Course No.: **0311 09 Econ 2181**

Full Title of Course: **Economics**

Full Marks: **60** Time: **03 Hours** **Credit Hours: 2.0**

- The figure in the margin indicates full marks. The questions are of equal value.
- **Use separate sheet for each section.**

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1(a)	Explain why studying economics is indispensable for a network engineer. [L4, CLO1]	05
1(b)	Discuss the Production Possibility Curve (PPC) with a figure. [L2, CLO1]	05
2(a)	Define demand. [L1, CLO2]	02
2(b)	Distinguish between movement along the demand curve and shift of the demand curve with figures. [L4, CLO3]	04
2(c)	Identify the five magnitudes of price elasticity of demand. [L3, CLO3]	04
3(a)	Define utility. [L1, CLO2]	02
3(b)	Illustrate the concept of diminishing marginal utility with real-life example. [L5, CLO3]	03
3(c)	Diagrammatically explain how the indifference curve and budget line ensure the consumers' equilibrium. [L2, CLO3]	05
4(a)	Explain consumers' and producers' surplus with appropriate figure. [L2, CLO3]	04
4(b)	Differentiate inferior goods and normal goods. [L4, CLO2]	04
4(c)	What is cross elasticity of demand? [L1, CLO2]	02

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5(a)	Distinguish short run and long run production function. [L4, CLO2]	02
5(b)	Explain the three stages of law of variable proportion with figure. [L2, CLO4]	05
5(c)	Explain envelope curve. [L2, CLO2]	03
6(a)	Differentiate between GDP and GNP. [L2, CLO5]	02
6(b)	Apply any two methods of calculating national income. [L4, CLO5]	04
6(c)	Discuss circular flow of income of four sectors economy. [L4, CLO5]	04
7(a)	What do you mean by opportunity cost? [L1, CLO4]	02
7(b)	How do consumption, savings, and investments are interconnected? [L1, CLO5]	03
7(c)	How the monetary policy can control inflation in Bangladesh? [L1, CLO5]	05
8(a)	'Inflation occurs not only for excess demand but also for supply shock'- describe this statement in the demand pull and cost push inflationary context. [L4, CLO5]	07
8(b)	Describe the role of monetary policy in mitigating the inflationary pressure. [L4, CLO5]	03

Date: 17.06.2026

Khulna University, Khulna Time: 10.00 – 1.00

Electronics and Communication Engineering Discipline

2nd Year Term I Examination

Session: **2024-2025**

Course No.: **ECE 2107 (R)**

Full Title of the Course: **Signals and Systems**

Full Marks: **60** Time: **03** Hours Credit Hours: **03**

- The figure in the margin indicates full marks. The questions are of equal value.
- **Use separate sheet for each section.**

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1.(a) Let, $x(t) = \begin{cases} t+2, & t \leq -2 \\ 0, & -2 \leq t \leq 2 \\ t-2, & 2 \leq t \end{cases}$. Plot $x(t)$ and $x(t+2)$. 03

(b) Show that the signal $x(t) = \sin 3t$ is periodic. Also find its period. 03

(c) Find the even and odd parts of the signal $x(t) = \begin{cases} Ae^{-at}, & t > 0 \\ 0, & t < 0 \end{cases}$ and plot the results. 04

2.(a) Draw the system for the impulse response given by: $h(t) = h_1(t) * h_2(t) + h_3(t) * h_4(t)$ 02

(b) Determine the graphical convolution of $x(t) = Ae^{-t}, 0 \leq t < \propto$ and $h(t) = \frac{t}{T}, 0 \leq t < T$ 08

3.(a) Does the signal, $Q_m(t) = \sin mt, m = 1,2,3, \ldots\ldots\ldots$ over the interval $-\pi < t < \pi$ form an orthogonal set? If so find its energy. 03

(b) Find the exponential Fourier series of the signal $x(t) = \begin{cases} -k, & -1 < t < 0 \\ k, & 0 < t < 1 \end{cases}$. Also draw the line spectrum. 3+2+2 = 07

4.(a) Determine the Fourier transform of the signal, $x(t) = \cos\omega_o t$. 03

(b) Show that, $u(t) \leftrightarrow \pi\gamma(\omega) + \frac{1}{j\omega}$. [Symbols hold their usual meaning] 04

(c) State the principle of uncertainty. 03

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. Find the Laplace transform of the following signals using the properties of Laplace transform. 2.5×4 =10

   (i) $x(t) = t\, e^{-t} u(t)$

   (ii) $x(t) = t\, e^{-2t} \sin 2t\ u(t)$

   (iii) $x(t) = sin\frac{at}{t}$

   (iv) $x(t) = 1 - \frac{e^t}{t}$

6. Evaluate the response $y(t)$ of a continuous time system using Laplace transform with transfer function, $H(s) = \frac{1}{(s+2)(s+3)}$, for an input, $x(t) = e^{-t}\, u(t)$. 10

7.(a) Deduce the initial value of, $X(z) = \frac{z+2}{(z+1)(z+3)}$ 05

(b) Formulate the Z- transform and its associated ROC for the signal, 05

$$x[n] = 3\delta[n+2] + 2\delta[n] + \delta[n-1] - \delta[n-2].$$

8. Use convolution method to determine the inverse Z-transform of, $X(z) = \frac{z^2}{(z-2)(z-3)}$ 10

Date: 23/06/2026

Khulna University, Khulna
Electronics and Communication Engineering Discipline
Second Year **Second** Term Examination, Session: **2024-2025**

Course No.: **0714 09 CSE 2151**

Full Title of the Course: **Data Structures and Algorithms**

Credit Hours: **3.00** Full Marks: **60** Time: **03** Hours

- The figure in the margin indicates full marks. The questions are of equal value.
- **Use separate sheet for each section.**

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1(a) What is a data structure? We can easily use elementary data items in a program, so why do we need data structures? Explain with examples. [L-2; CLO-1] 04

1(b) Define a linear array with an example. [L-3; CLO-2] 02

1(c) Write an algorithm (pseudo-code) to find the maximum value from the 3rd row and the minimum value from the 4th column from a two-dimensional array. The size of the array is $m \times n$. [L-3; CLO-4] 04

2(a) What is Stack? Why is it known as LIFO? Write an algorithm for PUSH and POP operations on the stack. [L-4; CLO-4] 05

2(b) List the applications of Stack. What is recursion? Explain recursion for finding the factorial of a number in detail. [L-3; CLO-1] 05

3(a) Define a circular linked list with an example. [L-1; CLO-2] 02

3(b) All queues are lists, but not all lists are queues. Explain the statement with an example. [L-4; CLO-2] 03

3(c) Given an expression as follows: $5 + (9 * 2 + 2) * 8/2$. Convert the infix to a postfix expression and evaluate it using stack(s). Show all necessary steps and explain them. [L-5; CLO-2] 05

4(a) What is a queue? Why is it known as FIFO? Write an algorithm to insert and delete an element from a simple Queue. [L-4; CLO-3] 05

4(b) What are Circular Queue and Priority Queue? Write an algorithm to insert and delete an element from a Circular Queue. [L-3; CLO-3] 05

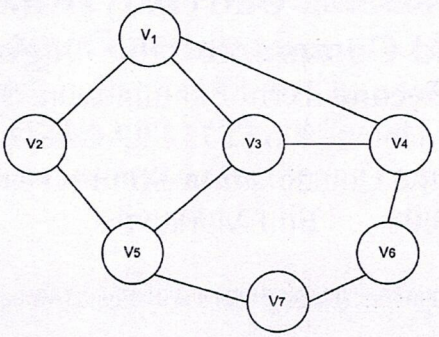
SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5(a) Define a full binary tree and a binary search tree with examples of each. [L-1; CLO-1] 02

5(b) Define a directed and weighted graph. Take (draw) a directed and weighted graph of five vertices and seven edges with weight (cost) and show an array representation of the graph. [L-2; CLO-2] 04

5(c) (a) Describe the Depth First Search (DFS) method for the following graph. [L-3; CLO-2] 04



6(a) Take (draw) a binary tree of 10 nodes. Explain how your binary tree can be represented using an array. [L-4; CLO-3] 03

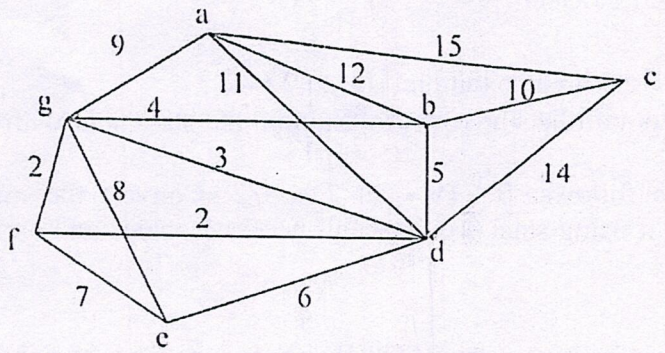
6(b) Write an algorithm (pseudo-code) to delete the value from the root of a max-heap. [L-4; CLO-4] 04

6(c) Take (draw) a binary search tree of 10 nodes. Now traverse the tree using the in-order method. You have to describe the traversal process. [L-3; CLO-2] 03

7(a) Take an array of 10 integers and show the selection sorting process for the data in the array. Describe the sorting process. [L-4; CLO-4] 03

7(b) What is hashing? What is the necessity of it? Explain with an example. [L-1; CLO-1] 03

7(c) What is a spanning tree of a graph? Find out the minimum spanning tree of the graph given below. [L-3; CLO-3] 04



8(a) What do you mean by the divide and conquer method? [L-2; CLO-1] 02

8(b) Write the Bellman and Ford algorithm to compute the shortest path to every vertex from the source vertex of a graph. [L-3; CLO-2] 04

8(c) Describe the process of quicksort with an example. [L-3; CLO-3] 04

Date: 28/06/2026

Khulna University, Khulna
Electronics and Communication Engineering Discipline
Second Year **First** Term Examination, Session: **2024-2025**
Course No.: **0541 09 Math 2171**
Full Title of the Course: **Coordinate Geometry and Vector Analysis**
Credit Hours: **3.00** Full Marks: **60** Time: **03** Hours

- The figure in the margin indicates full marks. The questions are of equal value.
- **Use separate sheet for each section.**

SECTION A
There are **FOUR** questions in this section. Answer any **THREE** questions.

1(a) Define and Sketch Pole and Polar Line with respect to a circle. [L-2; CLO-1] 02

1(b) Find the equation of the circle inscribed in the triangle determined by the lines $2x - 3y + 21 = 0; 3x - 2y - 6 = 0; 2x + 3y + 9 = 0$. [L-2; CLO-2] 04

1(c) Find the equation of the circle which cuts orthogonally each of the three circles $x^2 + y^2 + x + 2y + 3 = 0;\ x^2 + y^2 + 2x + 4y + 5 = 0; x^2 + y^2 - 7x - 8y + 9 = 0$; [L-2; CLO-2] 04

2(a) Prove that every first degree equation in x, y, z represents the equation of plane. [L-2; CLO-1] 05

2(b) So that the lines $\frac{x-5}{4} = \frac{y-7}{4} = \frac{z+3}{-5}$ and $\frac{x-8}{7} = \frac{y-4}{4} = \frac{z-5}{3}$ are co-planar, find their common point and the equation of the plane in which they lie. [L-2; CLO-1] 05

3(a) Reduce the equation $6x^2 + 5xy - 6y^2 - 4x + 7y + 11 = 0$ to the standard form. Find also it's lengths, equations and directions of the axes. [L-2; CLO-2] 05

3(b) Show that the equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ represents two parallel lines if $a:h = h:b = g:f$. Also show that the distance between them is $2\sqrt{\frac{g^2-ac}{a(a+b)}}$. [L-2; CLO-1] 05

4(a) What does the equation $x^2 + 2\sqrt{3}xy - y^2 = 2a^2$ become when the axes inclined at an angle 30^0. [L-3; CLO-3] 02

4(b) Prove that the straight lines represented by the equation $f(x, y) = 0$ will be equidistant from the origin, if $f^4 - bcf^2 = g^4 - cag^2$. where, $f(x, y) = ax^2 + 2hxy + by^2 + 2gx + 2fy + c$. [L-3; CLO-2] 04

4(c) If the two straight line represented by $x^2(tan^2\emptyset + cos^2\emptyset) - 2xy\ tan\emptyset + y^2 sin^2\emptyset = 0$ make angles α, β with the x axis, then show that $tan\alpha - tan\beta = 2$. [L-2; CLO-2] 04

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5(a) If $\vec{A} = 3\hat{\imath} - \hat{\jmath} - 4\hat{k}$, $\vec{B} = -2\hat{\imath} + 4\hat{\jmath} - 3\hat{k}$, $\vec{C} = \hat{\imath} + 2\hat{\jmath} - \hat{k}$, then find (i) $|3\hat{A} - 2\hat{B} + 4\hat{C}|$ and (ii) a unit vector parallel to $3\hat{A} - 2\hat{B} + 4\hat{C}$. [L-2; CLO-4] 04

5(b) Show that, $\vec{A} = 3\hat{\imath} - 2\hat{\jmath} + \hat{k}$, $\vec{B} = \hat{\imath} - 3\hat{\jmath} + 5\hat{k}$, $\vec{C} = 2\hat{\imath} + \hat{\jmath} - 4\hat{k}$ form a right angle triangle. [L-2; CLO-5] 03

5(c) If $\underline{a}, \underline{b}, \underline{c}$ are non-coplanar vectors determine whether the vectors, $\overrightarrow{r_1} = 2\underline{a} - 3\underline{b} + \underline{c}$, $\overrightarrow{r_2} = 3\underline{a} - 5\underline{b} + 2\underline{c}$, and $\overrightarrow{r_3} = 4\underline{a} - 5\underline{b} + \underline{c}$ are linearly independent or not. [L-2; CLO-5] 03

6(a) State Stokes theorem and Divergence theorem. [L-2; CLO-1] 02

6(b) Find the constants a, b, and c so that $\boldsymbol{V} = (-4x - 3y + az)\boldsymbol{i} + (bx + 3y + 5z)\boldsymbol{j} + (4x + cy + 3z)\boldsymbol{k}$ is irrotational. [L-3; CLO-2] 03

6(c) Verify Green's theorem in the plane for $\oint_C (3x^2 - 8y^2)dx + (4y - 6xy)dy$, where C is the boundary of the region defined by $y = \sqrt{x}$, $y = x^2$ and $x = 0, y = 0, x + y = 1$. [L-4; CLO-6] 05

7(a) Find the directional derivative of $P = 4e^{2x-y+z}$ at the point (1,1,-1) in a direction of $\boldsymbol{A} = -3\boldsymbol{i} + 5\boldsymbol{j} + 6\boldsymbol{k}$. In what direction the directional derivative is maximum? What is the magnitude of the maximum? [L-3; CLO-2] 05

7(b) Let $\boldsymbol{A} = (2y + 3)\boldsymbol{i} + xz\,\boldsymbol{j} + (yz - x)\boldsymbol{k}$. Evaluate $\int_C \boldsymbol{A}.\boldsymbol{dr}$ along the following paths C: *i)* $x = 2t^2, y = t, z = t^3$ from $t = 0$ to $t = 1$. *ii)* the straight lines from (0,0,0) to (0,0,1), then to (0,1,1), and then to (2,1,1). [L-5; CLO-3] 05

8(a) Evaluate $\iint_S \boldsymbol{A}.\boldsymbol{n}\,dS$, where $\boldsymbol{A} = 18z\,\boldsymbol{i} - 12\boldsymbol{j} + 3y\boldsymbol{k}$ and S is that part of the plane $2x + 3y + 6z = 12$, which is located in the first octant. [L-5; CLO-6] 05

8(b) Verify Stoke's theorem for $\boldsymbol{A} = (2x - y)\boldsymbol{i} - yz^2\,\boldsymbol{j} - y^2z\,\boldsymbol{k}$, where S is the upper sphere $\boldsymbol{x^2 + y^2 + z^2 = 1}$ and C is its boundary. Let R is the projection of S on the **xy** plane. [L-4; CLO-4] 05

Date: 01-07-2026

Khulna University, Khulna

Electronics and Communication Engineering Discipline
Second Year, Term I Examination
Session: 2024-2025
Course No.: **0714 09 ECE 2201(R)**
Full Title of Course: **Solid State Electronic Devices**
Full Marks: **60** Time: **03 Hours** Credit Hours: **03**

* **The figures in the margin indicate full marks. The questions are of equal value.**
* **Use separate sheet for each section.**

Section A

There are **Four** questions in this section. Answer any **Three** questions.

1(a) Explain the concept of a unit cell. Discuss why a unit cell, that is not a primitive unit cell, might be preferable to a primitive unit cell. [L-2; CLO-1] 2+2 = 04

1(b) Assume that each atom is a hard sphere with the surface of each atom in contact with the surface of its nearest neighbor. Determine the percentage of total unit cell volume that is occupied in (i) a simple cubic lattice, (ii) a face-centered cubic lattice, (iii) a body-centered cubic lattice, and (iv) a diamond lattice. [L-5; CLO-4] 04

1(c) Illustrate various defects in a single-crystal lattice. [L-1; CLO-1] 02

2(a) Interpret the concept of quantum tunneling. An electron is described by a wave function given by $\psi(x) = \sqrt{\frac{2}{a}}\cos\left(\frac{\pi x}{a}\right)$ for $-a/2 < x < +a/2$. The wave function is zero elsewhere. Calculate the probability of finding the electron between (i) $0 < x < a/4$, (ii) $a/4 < x < a/2$, and (iii) $-a/2 < x < +a/2$. [L-5; CLO-4] 1+3 = 04

2(b) Briefly describe Fermi–Dirac statistics and explain the significance of the Fermi level in determining electron occupancy in solids. Show that the probability of an energy state being occupied ΔE above the Fermi energy is the same as the probability of a state being empty ΔE below the Fermi level. [L-1,2,5; CLO-4] 2+4 = 06

3(a) Silicon at T = 300 K is doped with arsenic atoms such that the concentration of electrons is $n_0 = 7 \times 10^{15}$ cm^{-3}. (i) Find $E_c - E_F$. (ii) Determine $E_F - E_v$. (iii) Calculate p_0. (iv) Which carrier is the minority carrier? (v) Find $E_F - E_{Fi}$. [L-5; CLO-4] 05

3(b) State and explain the Einstein relation relating diffusion coefficient and mobility. Describe the Hall effect and explain why the polarity of the Hall voltage changes depending on the conductivity type (n-type or p-type) of the semiconductor. [L-1,2,4; CLO-3] 2+3 = 05

4(a) Explain why the depletion region is wider on the more lightly doped side of a *pn* junction. The doping concentrations in a uniformly doped silicon *pn* junction are $N_a = 4 \times 10^{16}$ cm^{-3} and $N_d = 2 \times 10^{15}$ cm^{-3}. The measured built-in potential barrier is $V_{bi} = 0.550$ V. Determine the temperature at which this result occurs. [L-4,5; CLO-4] 2+3 = 05

4(b) A silicon *pn* junction at T = 300 K is doped with impurity concentrations of $N_d = 2 \times 10^{16}$ cm^{-3} and $N_a = 5 \times 10^{16}$ cm^{-3}. The junction is forward biased at $V_a = 0.650$ V. Determine the minority carrier concentrations at the space charge edges. Does low injection still apply? [L-2,5; CLO-4] 05

Section B

There are **Four** questions in this section. Answer any **Three** questions.

5(a) Why p-channel JFET is usually lower frequency device? [L-2; CLO-2,5] 02

5(b) Calculate the internal pinch-off voltage and pinch-off voltage of a p^+n junction by a uniformly doped silicon JFET at 300 K temperature, $N_a = 10^{18}$ cm^{-3}, $N_d = 10^{16}$ cm^{-3}, $n_i = 1.5 \times 10^{10}$ with channel thickness is 0.75 μm. [L-3; CLO-2, 5] 04

5(c) Calculate the maximum current in a Si n-channel JFET at 350 K temperature with the following parameters: $N_a = 10^{18}$ cm^{-3}, $N_d = 10^{16}$ cm^{-3}, $n_i = 1.5 \times 10^{10}$, $a = 0.75$ μm, $L = 10$ μm, $W = 30$ μm, $\mu_n = 1000$ cm^2/V-s. [L-3; CLO-2, 5] 04

6(a) Explain the effect of interface states on the characteristics of a Schottky barrier diode. [L-4; CLO-2] 05

6(b) Determine the following expression for Figure 6(b). [L-5; CLO-2] 05

$$I_{D1} = I_{P1}\left[3\left(\frac{V_{DS}}{V_{p0}}\right) - 2\left(\frac{V_{DS} + V_{bi} - V_{GS}}{V_{p0}}\right)^{3/2} + 2\left(\frac{V_{bi} - V_{GS}}{V_{p0}}\right)^{3/2}\right]$$

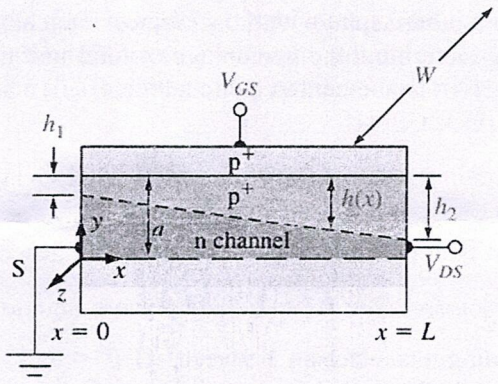


Figure 6(b)

7(a) Sketch the ideal energy-band diagram of a metal–semiconductor junction in which $\phi_m < \phi_s$. Explain why this is an ohmic contact. [L-3; CLO-2, 4, 5] 03

7(b) Explain the conditions of the cutoff, saturation, and inverse-active modes. [L-2; CLO-2, 4, 5] 03

7(c) Define and describe the three limiting factors in the common-base current gain. Why does the base doping concentration affect the emitter injection efficiency? [L-3; CLO-2, 4, 5] 04

8(a) Sketch the energy-band diagrams in a MOS capacitor with an n-type substrate in accumulation, depletion, and inversion modes. [L-3; CLO-2, 5] 04

8(b) Define surface potential. Does the surface potential change significantly with gate voltage once threshold is reached? [L-2; CLO-2, 5] 03

8(c) What is the effect on the C–V characteristics of a MOS capacitor with a p-type substrate if the amount of negative trapped oxide charge increases? [L-2; CLO-2, 5] 03

Date: 01-07-2026

Khulna University, Khulna

2nd Year, Term I Examination

Session: 2024-2025

Electronics and Communication Engineering Discipline

Course No.: **ECE 2201(R)**

Full Title of Course: **Solid State Electronic Devices**

Full Marks: **60** Time: **03 Hours** Credit Hours: **03**

- The figure in the margin indicates full marks. The questions are of equal value.
- **Use separate sheet for each section.**

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1(a) What is a lattice? Sketch three lattice structures: (i) simple cubic, (ii) body-centered cubic, and (iii) face-centered cubic. 1+3 = 04

1(b) Assume the radius of an atom, which can be represented as a hard sphere, is r = 1.95 Å. The atom is placed in a (i) simple cubic, (ii) fcc, (iii) bcc, and (iv) diamond lattice. Assuming that nearest atoms are touching each other, what is the lattice constant of each lattice? 04

1(c) Briefly describe the Czochralski method for silicon crystal growth. 02

2(a) Examine whether an electron confined within a potential well may have arbitrary energy values, and explain the underlying reasons. An electron is described by a wave function given by $\psi(x) = \sqrt{\frac{2}{a}}\cos\left(\frac{\pi x}{a}\right)$ for –a/2 < x < +a/2. The wave function is zero elsewhere. Calculate the probability of finding the electron between $a/4 < x < a/2$. 2+2 =04

2(b) Define Fermi–Dirac statistics and explain the physical meaning of the Fermi level. Calculate the temperature at which there is a 10^{-8} probability that an energy state 0.60 eV above the Fermi energy level is occupied by an electron. 3+3 =06

3(a) Silicon at T = 300 K is doped with boron atoms such that the concentration of holes is $p_0 = 5 \times 10^{15}$ cm^{-3}. (i) Find $E_c - E_F$. (ii) Determine $E_F - E_v$. (iii) Calculate n_0. (iv) Which carrier is the majority carrier? (v) Find $E_{Fi} - E_F$. 05

3(b) State and explain the Einstein relation that relates the diffusion coefficient and carrier mobility. Also, describe the Hall effect and explain why the polarity of the Hall voltage depends on whether the semiconductor is n-type or p-type. 2+3 =05

4(a) Explain why the space charge width is larger in the lower doped side of a *pn* junction. The doping concentrations in a uniformly doped silicon *pn* junction are $N_a = 2 \times 10^{17}$ cm^{-3} and $N_d = 4 \times 10^{16}$ cm^{-3}. (i) Determine V_{bi} at $T = 300$ K. (ii) Determine the temperature at which V_{bi} increases by 2 percent. 2+3 =05

4(b) A silicon *pn* junction at T = 300 K is doped with impurity concentrations of $N_d = 2 \times 10^{16}$ cm^{-3} and $N_a = 5 \times 10^{16}$ cm^{-3}. The junction is forward biased at $V_a = 0.650$ V. Determine the minority carrier concentrations at the space charge edges. Does low injection still apply? 05

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5(a) What is flat band voltage and conduction parameter? 03

5(b) Explain why FET is not current controlled device. 02

5(c) Determine the following expression for the Figure 5(c). 05

$$I_{D1} = \frac{\mu_n (eN_d)^2 Wa^3}{2\epsilon_s L}\left[\frac{V_{DS}}{V_{p0}} - \frac{2}{3}\left(\frac{V_{DS} + V_{bi} - V_{GS}}{V_{p0}}\right)^{3/2} + \frac{2}{3}\left(\frac{V_{bi} - V_{GS}}{V_{p0}}\right)^{3/2}\right]$$

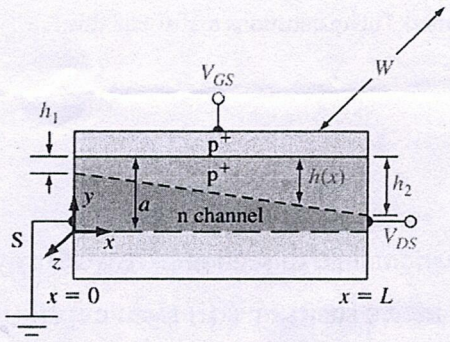


Figure 5(c)

6(a) Explain the pinch-off phenomena of typical JFET and show that the pinch-off voltage $v_p = \frac{qa^2N_d}{2\varepsilon}$, where the symbols have their usual meanings. 05

6(b) Sketch a *p*-channel MOSFET cross-section under different operating conditions. 05

7(a) Determine the following for the circuit of Figure 7(a): 05

(i) I_{D_Q} and V_{GS_Q}

(ii) V_D and V_S

(iii) V_{DS} and V_{DG}

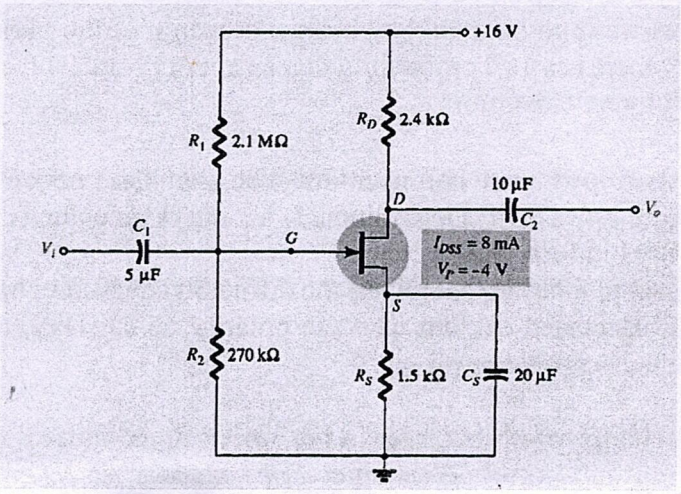


Figure 7(a)

7(b) Prove that current transfer ratio, $\gamma = \left[1 + \frac{L_p^n n_n \mu_n^p}{L_n^p p_p \mu_p^n} \tanh \frac{W_b}{L_p^n}\right]^{-1}$ where the symbols have their usual meanings. 05

8(a) Formulate the expression of mutual transconductance. 04

8(b) Using an energy-band diagram, indicate the effect of the Schottky barrier lowering. 04

8(c) Explain briefly the Debye screening length. 02

Date: 02/07/2026

Khulna University, Khulna
Electronics and Communication Engineering Discipline
Second Year **First** Term Examination, Session: **2024-2025**
Course No.: **0714 09 ECE 2101**
Full Title of the Course: **Electronic Amplifiers and Power Supply Circuits**
Credit Hours: **3.00** Full Marks: **60** Time: **03** Hours

- The figure in the margin indicates full marks. The questions are of equal value.
- **Use separate sheet for each section.**

SECTION A
There are **FOUR** questions in this section. Answer any **THREE** questions.

1(a) Define the term 'Loop Gain' and write the mathematical expression for the transfer gain with feedback (A_f). Discuss some general characteristics of negative feedback amplifiers. [CLO1; L2] 04

1(b) A basic amplifier has an open-loop voltage gain (A) of 1000. A negative feedback network with a feedback ratio (β) of 0.04 is applied to it. Calculate the resulting gain with feedback (A_f). If the open-loop gain (A) decreases by 10% due to aging, calculate the new A_f and determine the percentage change in the closed-loop gain. [CLO1; L3] 03

1(c) Consider two feedback topologies: Voltage-Series and Current-Shunt. Analyze the effect of each topology on the Input Resistance (R_i) and Output Resistance (R_o) of the amplifier. Justify which of these two topologies is most suitable for designing a Voltage Amplifier (where the goal is to have high input resistance and low output resistance). [CLO1; L4] 03

2(a) Identify the four types of feedback topologies based on the signal being sampled at the output and the signal being mixed at the input. Explain how Voltage-Series feedback differs from Voltage-Shunt feedback in terms of its effect on the input resistance (R_i) of the amplifier. Why does the mixing method (series vs. shunt) cause this difference? [CLO1; L3] 04

2(b) Draw the circuit diagrams for the following configurations: [CLO2; L2] 03
(i) a current-series feedback amplifier (ii) a voltage-shunt feedback amplifier

2(c) A designer needs to create a Current Amplifier (where the output current follows the input current regardless of load resistance). Which of the four feedback topologies—Current-Series or Current-Shunt—is better suited for this application? Justify your choice by comparing how each topology modifies both the input resistance (R_i) and the output resistance (R_o) to meet the ideal characteristics of a current amplifier. [CLO2; L4] 03

3(a) Consider a feedback amplifier with a single-pole transfer function. (i) What is the relationship between the high 3-db frequency with and without feedback? (ii) Repeat part (i) for the low 3-dB frequency, (iii) Repeat part (i) for the gain-bandwidth product. [CLO1; L3] 03

3(b) Draw a circuit diagram of a series operated crystal oscillator and explain its working principle. [CLO2; L2] 03

3(c) Define positive feedback. Explain with the aid of graphs (i) gain margin and (ii) phase margin. [CLO2; L2] 04

4(a) Explain how we can obtain an output signal without the existence of input signal for a sinusoidal oscillator? Give the two Barkhausen conditions required in order for sinusoidal conditions to be sustained. [CLO1; L2] 05

4(b) Sketch the circuit of a Wien bridge oscillator. What determines the frequency of oscillation? Will oscillations take place if the bridge is balanced? Explain. [CLO2; L4] 05

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5(a) A class A transformer-coupled amplifier uses a 25: 1 transformer to drive a 4-V load. Calculate the effective ac load (seen by the transistor connected to the larger turn's side of the transformer). [CLO 3; L3] 02

5(b) A transformer-coupled class A amplifier drives a 16-V speaker through a 3.87:1 transformer. Using a power supply of $V_{CC} = 36\ V$, the circuit delivers $2\ W$ to the load. Calculate: (i) P_{ac} across transformer primary,(ii) $V_{L(ac)}$, (iii) V_{ac} at transformer primary. (iv) The rms values of load and primary current. [CLO 1; L3] 08

6(a) For a class B amplifier providing a 22-V peak signal to an 8-Ω load and a power supply of $V_{CC} = 25V$, determine: (i) Input power, (ii) Output power, (iii) Circuit efficiency. [CLO 1; L3] 03×2 =06

6(b) Calculate the efficiency of a class B amplifier for a supply voltage of $V_{CC} = 22\ V$ driving a 4-V load with peak output voltages of: (i) $V_{L(p)} = 20\ V$, (ii) $V_{L(p)} = 4\ V$ [CLO 3; L3] 02×2 =04

7(a) A 160-W silicon power transistor operated with a heat sink (θ_{SA} 5 1.5°C/W) has θ_{JC} 0.5°C/W and a mounting insulation of θ_{CS}50.8°C/W. What maximum power can be handled by the transistor at an ambient temperature of 80°C? (The junction temperature should not exceed 200°C.) [CLO 1; L3] 03

7(b) Calculate the harmonic distortion components for an output signal having fundamental amplitude of 2.1 V, second harmonic amplitude of 0.3 V, third harmonic component of 0.1 V, and fourth harmonic component of 0.05 V. [CLO 2; L3] 03

7(c) A single tuned RF amplifier uses a transistor with an output resistance of 50 KΩ, output capacitance of 15 pF and internal resistance of next stage is 20 kΩ. The tuned circuit consists of 47 pF capacitance in parallel with series combination of 1μH inductance and 2Ω resistance. Calculate resonant frequency, effective quality factor and bandwidth of the circuit. [CLO 3; L3] 04

8(a) A filter circuit provides an output of 28 V unloaded and 25 V under full-load operation. Calculate the percent voltage regulation. [CLO 1; L3] 04

8(b) Calculate the output voltage and Zener current in the regulator circuit of Fig. Q8(b) for R_L = 1kΩ. [CLO 1; L3] 06

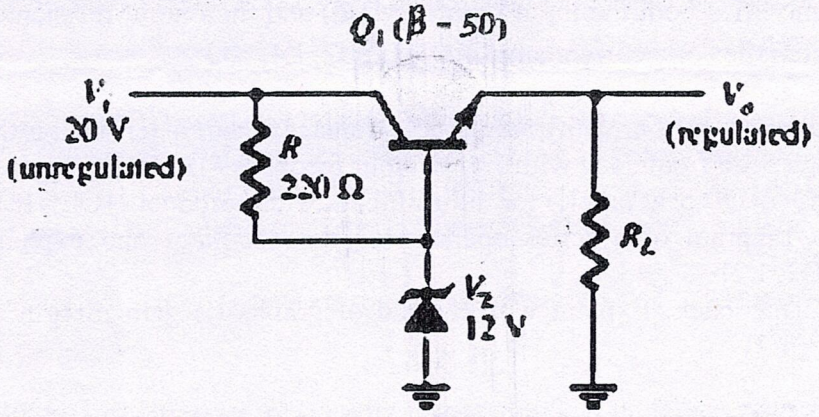


Fig. Q8(b)