KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 1st Year 2nd Term Examination, 2024

Ph 1205

(Physics II)

Time: 3 Hours | Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate script.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

1(a) Define inertial and non-inertial frame of references. 04

1(b) Derive an expression for relativistic kinetic energy and hence show that the classical kinetic energy is only an approximation. 13

1(c) Express the relativistic form of the total energy of a particle as: 08

$$E = m_o c^2 + \tfrac{1}{2} m_o v^2$$

where the notations have their usual meanings.

1(d) A spaceship is 100 *m* long on the ground. When it is in flight, its length is 99 *m* to an observer on the ground. What is its speed? 10

2(a) What is photoelectric effect? Discuss Einstein's explanation of photoelectric effect. 10

2(b) Considering the Compton scattering of X-rays derive expressions for (i) the Compton shift and (ii) the kinetic energy of the recoil electron. 15

2(c) A monochromatic X-ray beam whose wavelength is 0.558 $\AA$ is scattered through 46°. Find the wavelength of the scattered beam. 10

3(a) What are the basic postulates of Bohr's atom model? On the basis of this model, derive the expressions of wavelength for different spectral series of Hydrogen atom. 15

3(b) Show that the quantum physics gives the same results as classical physics in case of large quantum numbers. 10

3(c) Find the wavelength of the spectral line corresponding to the transition in the Hydrogen Atom from $n = 4$ state to $n = 2$ state. 10

4(a) What are the basic laws of radioactive disintegration? Prove that, $N = N_o e^{-\lambda t}$, where symbols have their usual meanings. Hence, show that $T_{1/2} = 0.693\tau$. 15

4(b) Discuss Carbon-Nitrogen cycle of nuclear fusion. 10

4(c) The half life period of radium is 1620 years. In how many years will one gram of pure element i) lose one centigram and ii) be reduced to one centigram? 10

SECTION-B

5(a) Explain the coherence, directionality and monochromaticity of LASER. 09

5(b) What is the necessity of metastable state to obtain LASER? 04

5(c) Describe the construction and working principle of Ruby LASER. 12

5(d) A LASER beam has a power of 55 mW. It has an aperture of 5.5 x 10^{-4} m and it emits light of wavelength 6000 $\AA$. The beam is focused with a lens of focal length 0.15 m. Calculate the area and intensity of the image. 10

6(a) What is atomic packing factor? Calculate atomic packing factor for simple, face centered and body centered cubic structures. 13

6(b) Show that for a cubic lattice the interplanar separation between a set of (hkl) planes is given by 12

$$d_{hkl} = \frac{a}{\sqrt{(h^2 + k^2 + l^2)}}$$

where a is the lattice parameter.

6(c) A diffraction pattern is obtained for lead with radiations of wavelength 1.54 $\AA$. The (220) reflection is observed at Bragg angle, 32°. What is the lattice parameter of lead and the radius of the atom? (Lead has fcc structure). 10

7(a) Distinguish between metals, semiconductors and insulators on the basis of band theory of solids. 08

7(b) What is Hall effect? Mention the importance of Hall effect. 07

7(c) According to Einstein's model, the average energy of an oscillator is 10

$$\bar{E} = \frac{1}{2}h\upsilon + \frac{h\upsilon}{e^{h\upsilon/k_BT} - 1} .$$

Now obtain an expression for lattice heat capacity for a crystal of N number of atoms. Discuss the success and failure of this model.

7(d) The Debye temperature for carbon (diamond structure) is 1850 K. Calculate the specific heat per mole for diamond at 10 K and the highest lattice frequency. 10

8(a) Obtain the expressions for thermal and electrical conductivities according to classical free electron theory of metals and hence prove the Wiedemann-Franz law. 15

8(b) Show that the average kinetic energy of a free electron is 3/5 E_f, where E_f is Fermi energy and average speed is 3/4 v_f, where v_f is the velocity of electron at Fermi surface. 10

8(c) Copper has a mass density of 8.9 x 10^3 kg/m^3 and an electrical conductivity 6.5 x 10^7 *mho/meter* at room temperature. Calculate (i) mean free time, (ii) Fermi energy and (iii) Fermi velocity. 10

----------END----------

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering **1st Year 2nd Term** Examination, **2024**

EE 1205

(Electrical Engineering & Electrical Machines)

Time: 3 Hours | Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate script.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

1(a) Define phase difference, leading power factor, and lagging power factor. Also, find the phase difference between $i = -2\cos(wt - 90°)$ and $v = 3\sin(wt - 150°)$. 08

1(b) What is form factor and crest factor? Find the form factor and crest factor of the wave shown in the Fig. 1(a). 10

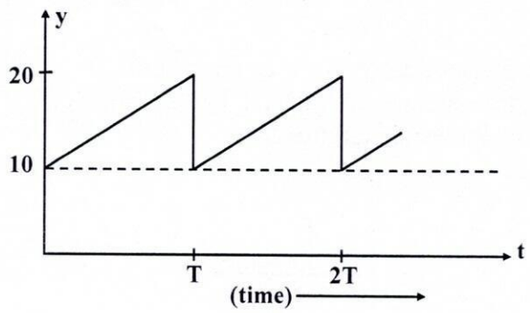

Fig. 1 (a)

1(c) Derive the expression of impedance, current, and power in a series circuit consists of i) *R-L* branch, ii) *R-L-C* branch. Also, draw their vector diagram and show what happen when $X_L > X_C$ and $X_C > X_L$. 13

1(d) Explain Active Power, Reactive Power, and Apparent Power. 04

2(a) Define maximum power transfer theorem. Derive the condition for maximum power transfer. 12

2(b) Define supernode. Find the node voltages of the circuit shown in Fig. 2 (b). Also, find power of each of the resistor. 11

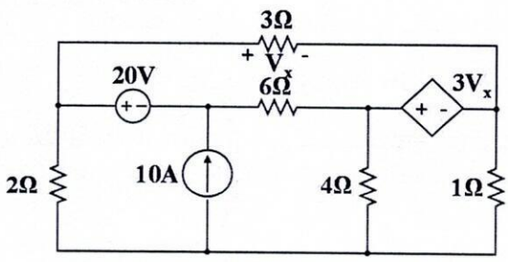

Fig. 2 (b)

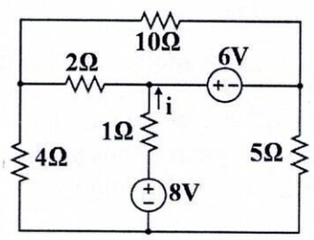

Fig. 2 (c)

2(c) Define supermesh. Using mesh analysis, find *i* of the circuit shown in Fig. 2 (c). 12

3(a) State and explain the Thevenin's theorem. Obtain the Thevenin equivalent at terminals *a-b* of the circuit shown in Fig. 3 (a). 10

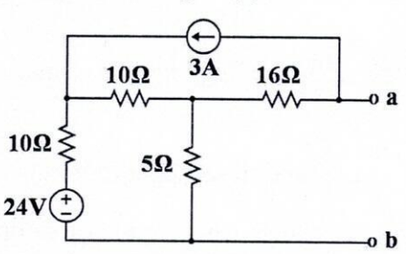

Fig. 3 (a)

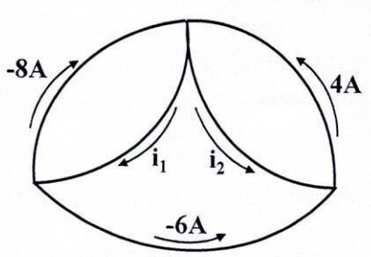

Fig. 3 (b)

3(b) Determine i_1 and i_2 in the circuit shown in Fig. 3 (b). 05

3(c) Calculate total admittance, conductance, and succeptance of the circuit shown in Fig. 3 (c). What will be the total current and total power factor? What will be the value of pure capacitance to be connected in parallel to make total power factor unity? 10

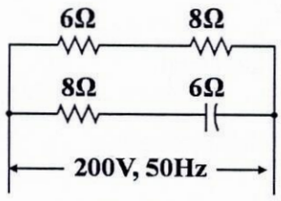

Fig. 3 (c)

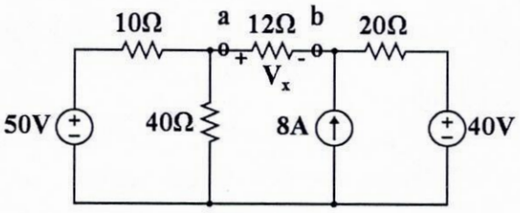

Fig. 3 (d)

3(d) Explain source transformation with neat sketch. Apply source transformation to find V_x in the circuit shown in Fig. 3 (d). 10

4(a) Explain the principle and construction of a DC generator. 10

4(b) Classify DC generator based on magnetic field excitation with neat sketch. 07

4(c) How d.c. current is obtained from a dc generator although the ac voltage is induced in the armature? 10

4(d) A long shunt compound generator delivers a load current of 50 A at 240 V, and has armature, series-field and shunt-field resistances of 0.05 Ω, 0.30 Ω, and 200 Ω, respectively. Calculate E_g and I_a. Allow $1V$ per brush for contact drop. 08

SECTION-B

5(a) What is back e.m.f.? What is its significance? 07

5(b) Why starters are needed for a DC motor operation? Mention some typical applications of DC motor. 08

5(c) Derive the speed equation of a DC motor. What will happen if the field winding of a dc shunt motor is suddenly opened? 08

5(d) Compare the loading characteristics of dc shunt and series generators. Explain why do they show different characteristics with load? 12

6(a) Briefly explain the working principle of a 3-φ induction motor 07

6(b) How revolving field is produced in a 3-φ induction motor? Justify your answer. 13

6(c) Can an induction motor run at synchronous speed? Explain your logic. 07

6(d) What is slip? A 3-φ induction motor is wound for 4-poles and is supplied from 50 *Hz* system. Calculate the synchronous speed, rotor speed when slip is 5% and the rotor current frequency when the rotor runs at 300 *rpm*. 08

7(a) What is transformer? Why transformers are need in power system? 08

7(b) What are the common losses occur in electrical transformer? How these losses can be measured and also how these losses can be reduced? 14

7(c) A single-phase 50 *Hz*, 200/400 *V* transformer provides the following test data: 13
OC test (LV side): 200 *V*, 0.7 *A*, 70 *W*
SC test (HV side): 15 *V*, 10 *A*, 85 *W*
Calculate the secondary voltage when delivering 5 *kW* at 0.8 *p.f.* lagging, the primary voltage is 200 *V*.

8(a) Write short note on- i) Alternator, ii) Synchronous motor, and iii) Stepper motor. 12

8(b) Derive the torque relationship of induction motor. Why the starting torque of squirrel cage motor is very poor? How can we improve it? 13

8(c) What is meant by plugging? Compare the dynamic braking and regenerative braking and where it can be used? 10

----------END----------

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 1st Year 2nd Term Examination, 2024

Hum 1205

(Economics and Accounting)

Time: 3 Hours | Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate script.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

1. Consider the following table and answer the questions below: 35

Price ($ per bushel)	Demand for wheat (millions bushel)	Supply of wheat (millions bushel)
5	35	15
6	25	17
7	20	20
8	10	25
9	02	27

i) Define market equilibrium. Find out equilibrium price and quantity.

ii) What is price ceiling? If the government fixed a price ceiling of wheat per bushel at $8, will there be surplus or shortage in the market?

iii) What is floor price? If the floor price is $5, explain the market conditions with the help of diagram.

iv) Explain the factors that affect the demand curve to shift.

2(a) What is meant by utility? Explain the law of diminishing marginal utility. 10

2(b) Explain with diagram the short-run equilibrium of a firm under perfect competition. 15

2(c) Discuss the different types of market structure. Evaluate if firms in a perfect competition market are price taker or price maker. 10

3(a) What is GNP deflator? Distinguish between GNP and GDP. 07

3(b) Define national income and personal income. Make a comparative study among different methods of national income. 13

3(c) 'Rising bank rate'- the central bank tries to combat inflation, explain. 15

4(a) Show the relationship between total cost, fixed cost, variable cost and marginal cost; and show it in figure. 10

4(b) What information do we get from production function? "A rational producer always tries to produce in stage-2"-Explain. 20

4(c) What are the functions of an organizer? 05

SECTION-B

5(a) How to apply your accounting knowledge in engineering professional life? 07

5(b) On April 1, 2025, "Vertex Engineering Services" was established in Dhaka by Khadiza Rahman, a former BUET student, who decided to start her own engineering consultancy firm providing design, feasibility, and project management services. The following transactions occurred during April, 2025: 28

i) Invested Tk. 15,00,000 cash to start the business.

ii) Paid 60,000 Tk. cash for April's office rent.

iii) Purchased engineering equipment for Tk. 3,00,000 and paid the amount via bank transfer.

iv) Incurred Tk. 70,000 for advertising in a national newspaper on account.

v) Paid Tk. 90,000 in cash for office supplies.

vi) Performed engineering and consultancy services worth Tk. 8,00,000 of which received Tk. 5,00,000 in cash and the remaining was on account.

vii) Withdrew Tk. 50,000 in cash for personal use.

viii) Paid the due amount owed for advertising. (Transaction -iv).

ix) Tk. 25,000 cash was stolen from the office cash box.

x) Received Tk. 3,00,000 in cash from clients who were billed previously in transaction- vi

Instructions:

i) Prepare journal entries of the above transactions.

ii) Post to the ledger accounts. (Any four including Cash Account).

6(a) Explain the types of business organizations based on their activity. 09

6(b) Discuss about the types of users of accounting information. 06

6(c) "Pioneer Mechanical Engineering Consultants Ltd." Provides mechanical design, fabrication, and plant maintenance services. The following ledger balances were extracted from the company's books on 31 December, 2024: 20

Capital 15,00,000; Service Income from Industrial Projects 7,70,000; Machine Maintenance Expense 35,000; Cash in hand (1-1-24) 8,00,000; Return outward 10,000; Bank balance (31-12-24) 5,00,000; Bills payable 1,20,000; Interest accrued on Fixed Deposit 4,500; Discount allowed 20,000; Fixed Deposit Receipt (FDR) 4,00,000; Allowance for bad debt 10,000; Workshop Insurance Premium 35,000; Machine Installation & Maintenance Income 70,000; Drawings 55,000; Creditors 1,70,000; Bank Balance (1-1-24) 4,00,000; Patents 1,50,000; Workshop tools & Equipment 5,00,000; 10% Mortgage Loan 2,00,000; CAP software license 1,00,000; Cash in Hand (31-12-24) 8,00,000; Account Receivable 2,50,000.

Required: Prepare a Trial Balance of Pioneer Mechanical Engineering Consultants Ltd. As on 31 December, 2024.

7(a) The following data taken from the records of "Apple Inc." for the fiscal year ended June 30, 2025: 20

Items	$	Items	$
Raw Materials:		Work in Process:	
1/7/24	48,000	1/7/24	19,800
30/6/25	39,600	30/6/25	18,600
Finished Goods:		Indirect labor	24,460
1/7/24	96,000	Factory-Insurance	4,600
30/6/25	75,900	Factory-Depreciation	16,000
Direct labor	1,39,250	Factory-Utilities	8,650
Office Utilities	8,650	Factory Repairs	1,400
Sales Revenue	5,34,000	Raw Materials Purchase	96,400
Sales Discounts	4,200	Account Receivable	27,000
Plant Manager's Salary	58,000	Cash (30/06/25)	32,000
Factory Property Taxes	9,600	---	---

Instructions:

i) Prepare a statement of cost.
ii) Prepare an income statement.

7(b) Write short notes on the following terms: 15

i) IFRS

ii) Mixed Cost

iii) Suspense Account

iv) Matching Principle

v) Ledger

8. "Titan Mechanical Supplies Ltd." is a medium-sized distributor of industrial machine parts, bearing, hydraulic fitting, power-transmission components, and workshop tools. The company purchases mechanical components from local manufacturer and imports specialty parts for resale to factories, repair shops and construction firms. 35
The following trial, balance was extracted from the company's ledger after posting all routine transactions for the year:

Titan Mechanical Supplies Ltd.
Trial Balance
December 31, 2024

Account Titles	Debit Tk.	Credit Tk.
Sales (Industrial components)		18,00,000
Cash in Hand	70,000	
Account Payable		1,00,000
Account Receivable	1,50,000	
Purchase & Sales Returns	50,000	25,000
Opening Inventory	1,00,000	
Capital & Drawings	1,00,000	150,00,000
Carriage Inward	40,000	
Administrative Expenses	2,50,000	
Wages (Warehouse & Machine Handling Staff)	2,00,000	
Insurance	30,000	
Premises	12,00,000	
Equipment	2,00,000	
Allowance for bad debt		15,000
Purchases-Industrial Components	9,50,000	
Selling & Distribution Expenses	1,00,000	
Total	3,44,00,000	3,44,00,000

Other information:

i) Closing Inventory is Tk. 80,000.

ii) Tk. 10,000 of the wages related to the next accounting period.

iii) Tk. 20,000 accrued for administrative expenses during 2024.

iv) The firm maintains an allowance for bad debt @ 12% of account receivable due to credit risk from small engineering workshops.

v) Charge depreciation on equipment @ 20%.

Required: Prepare-

(i) A statement of Comprehensive Income.

(ii) A statement of Owner's Equity.

(iii) A statement of Financial Position.

----------**END**----------