BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2020-2021

Sub : **CHE 101** (Elementary Principles of Chemical Engineering)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

A data booklet containing data needs to be provided.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) The rate at which a substance passes through a semipermeable membrane is determined by the *diffusivity* D (cm^2/s) of the gas. D varies with the membrane temperature T (K) according to the Arrhenius equation: (15)

$$D = D_0 exp\left(-\frac{E}{RT}\right)$$

where D_0 = the preexponential factor

E = the activation energy for diffusion

R = 1.987 cal/(mol.K)

Diffusivities of SO_2 in a fluorosilicons rubber tube are measured at several temperatures, with the following results:

T (K)	D (cm^2/s) × 10^6
347.0	1.34
374.2	2.50
396.2	4.55
420.7	8.52
447.7	14.07
471.2	19.99

(i) What are the units of D_0 and E?

(ii) How should the data be plotted to obtain a straight line on rectangular coordinates?

(iii) Plot the data in the manner indicated in part (ii) and determine D_0 and E from the resulting line. (Graph paper will be supplied in the exam hall).

(b) The analysis of a coal indicates 75 wt% C, 17% H, 2% S, and the balance noncombustible ash. The coal is burned at a rate of 5000 kg/h, and the feed rate of air to the furnace is 50 kmol/min. All of the ash and 6% of the carbon in the fuel leave the furnace as a molten slag; the remainder of the carbon leaves in the stack gas as CO and CO_2; the hydrogen in the coal is oxidized to water, and the sulfur emerges as SO_2. The selectivity of CO_2 to CO production is 10:1. (20)

Contd P/2

CHE 101

Contd ... Q. No. 1(b)

(i) Calculate the percent excess air fed to the reactor.

(ii) Calculate the mole fractions of the gaseous pollutants-CO and SO_2-in the stack gas.

(iii) Emitted sulfur dioxide by itself is a health hazard, but it is a more serious threat to the environment as a precursor to acid rain. Under the catalytic action of sunlight, the sulfur dioxide is oxidized to sulfur trioxide, which in turn combines with water vapor to from sulfuric acid, which eventually returns to earth as rainfall. Acid rain formed in this manner has caused extensive damage to forests, fields and lakes in many parts of the world. For the furnace described above, calculate the rate of formation of sulfuric acid (kg/h) if all the emitted SO_2 is converted in the indicated manner.

2. (a) Acetylene is hydrogenated to form ethane. The feed to the reactor contains 1.50 mol H_2/mol C_2H_2. (10)

(i) Calculate the stoichiometric reactant ratio (mol H_2 react/mol C_2H_2 react) and the yield ratio (kmol C_2H_2 formed/kmol H_2 react).

(ii) Determine the limiting reactant and calculate the percentage by which the other reactant is in excess.

(iii) Calculate the mass feed rate of hydrogen (kg/s) required to produce 4,106 metric tons of ethane per year, assuming that the reaction goes to completion and that the process operates for 24 hours a day, 300 days a year.

(b) A liquid mixture containing 30.0 mole% benzene (B), 25.0% toluene (T), and the balance xylene (X) is fed to a distillation column. The bottoms product contains 98.0 mole% X and no B, and 96.0% of the X in the feed is recovered in this stream. The overhead product is fed to a second column. The overhead product from the second column contains 97.0% of the B in the feed to this column. The composition of this stream is 94.0 mole% B and the balance T. (25)

(i) Draw and label a flowchart of this process and do the degree-of-freedom analysis to prove that for an assumed basis of calculation, molar flow rates and compositions of all process streams can be calculated from the given information. Write in order the equations you would solve to calculate unknown process variables. In each equation (or pair simultaneous equations), circle the variable(s) for which you would solve.

(ii) Calculate the percentage of the benzene in the process feed that emerges in the overhead product from the second column and the percentage of toluene in the process feed that emerges in the bottom product from the second column.

Contd P/3

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3. Ethylene oxide is produced by the catalytic oxidation of ethylene: (35)

$$2\,C_2H_4 + O_2 \rightarrow C_2H_4O$$

An undesired competing reaction is the combustion of ethylene:

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

The feed to the reactor (not the fresh to the process) contains 3 moles of ethylene per mole of oxygen. The single-pass conversion of ethylene is 20%, and for every 100 moles of ethylene consumed in the reactor, 90 moles of ethylene oxide emerge in the reactor products. A multiple-unit process is used to separate the products: ethylene and oxygen are recycled to the reactor, ethylene oxide is sold as a product, and carbon dioxide and water are discarded.

(a) Assume a quantity of the reactor feed stream as a basis of calculation, draw and label the flowchart, perform a degree-of-freedom analysis, and write the equations you would use to calculate (i) the molar flow rates of ethylene and oxygen in the fresh feed, (ii) the production rate of ethylene oxide, and (iii) the overall conversion of ethylene.

(b) Calculate the quantities specified in Part (a).

(c) Calculate the molar flow rates of ethylene and oxygen in the fresh feed needed to produce 1 ton per hour of ethylene oxide.

4. Methane and oxygen react in the presence of a catalyst to form formaldehyde. In a parallel reaction, methane is oxidized to carbon dioxide and water: (35)

$$CH_4 + O_2 \rightarrow HCHO + H_2O$$

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

The feed to the reactor contains equimolar amounts of methane and oxygen

(a) Assume a basis then draw and label flowchart.

(b) Use a degree-of-freedom analysis based on extents of reaction to determine how many process variable values must be specified for the remaining variable values to he calculated.

(c) Derive expressions for the product stream component flow rates in terms of the two extents of reaction, $\xi 1$ and $\xi 2$.

(d) The fractional conversion of methane is 0.900 and the fractional yield of formaldehyde is 0.855. Calculate the molar composition of the reactor output stream and the selectivity of formaldehyde production relative to carbon dioxide production.

Contd P/4

CHE 101

SECTION – B

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

5. (a) Write and simplify the closed-system energy balance for each of the following processes, and state whether nonzero heat and work terms are positive or negative. Begin by defining the system. (20)

   (i) The contents of a closed flask are heated from 25°C to 80°C.

   (ii) A tray filled with water at 20°C is put into a freezer. The water turns into ice at 5°C. (When a substance expands it does work on its surroundings and when it contracts the surroundings do work on it).

   (iii) A chemical reaction takes place in a closed adiabatic (perfectly insulated) rigid container.

   (iv) Repeat part (iii), only suppose that the reactor is isothermal rather than adiabatic and that when the reaction was carried out adiabatically the temperature in the reactor increased.

   (b) A small storage room whose dimensions are 2m × 15m × 3m contains a number of expensive and dangerous chemicals. To prevent unauthorized entry, the room door is always locked and can be opened with a key from either side. A cylinder of liquid carbon dioxide is stored in the room. The valve on the cylinder is faulty and some of the contents have escaped over the weekend. The room temperature is 25°C. (15)

   (i) If the concentration of CO_2 reaches the lethal 75 mole% level (at 75% death occurs in a matter of minutes), what would be the mole percent of O_2 in the room?

   (ii) How much CO_2 (kg) is present in the room when the lethal concentration is reached?

   (iii) Suggest at least three measures that would reduce the hazards associated with storage of this seemingly harmless substance.

6. (a) Superheated stream at 40 bar absolute and 500°C flows at a rate of 250 kg/min to an adiabatic turbine, where it expands to 5 bar. The turbine develops 1500 kW. From the turbine the steam flows to a heater, where it is reheated isobarically to its initial temperature. Neglect kinetic energy changes. (21)

   (i) Write an energy balance on the turbine and use it to determine the outlet stream temperature.

   (ii) Write an energy balance on the heater and use it to determine the required input (kW) to the steam.

   (iii) Verify that an overall energy balance on the two-unit process is satisfied.

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CHE 101

Contd ... Q. No. 6

(b) A gas stream contains 18.0 mole% hexane and the remainder nitrogen. The stream flows to a condenser, where its temperature is reduced and some of the hexane is liquefied. The hexane mole fraction in the gas stream leaving the condenser is 0.0500. Liquid hexane condenser is recovered data rate of 1.50 L/min. (14)

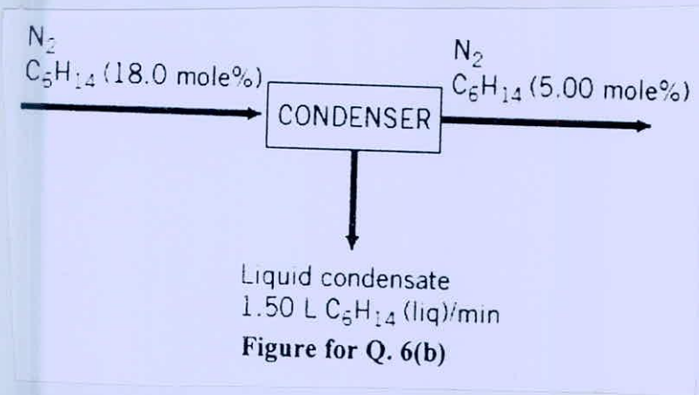

Figure for Q. 6(b)

(i) What is the flow rate of the gas stream leaving the condenser in mol/min?

(ii) What percentage of the hexane entering the condenser is recovered as a liquid?

7. (a) A mixture contains 10.0 mole% ethyl alcohol, 75.0 mole% ethyl acetate ($C_4H_8O_2$), and 15.0 mole% acetic acid. Calculate the mass fractions of each compound. What is the average molecular weight of the mixture? What would be the mass (kg) of a sample containing 25.0 kmol of ethyl acetate? (20)

(b) Two hundred kg/min of stream enters a steam turbine at 350°C and 40 bar through a 7.5 cm diameter line and exit at 75°C and 5 bar through a 5 cm line. The exiting stream may be vapor, liquid, or "wetsteam" (15)

(i) If the exiting stream were wet steam at 5.0 bar, what would its temperature be?

(ii) How much energy is transferred to or from the turbine? (Neglect $\Delta\dot{E}_P$ but not $\Delta\dot{E}_K$)

8. (a) A gas cylinder filled with nitrogen at standard temperature and pressure has a mass of 37.289 g. The same container filled with carbon dioxide at STP has a mass of 37.440 g. When filled with an unknown gas at STP, the container mass is 37.062 g. Calculate the molecular weight of the unknown gas, and then state its probable identity. (15)

(b) The heart pumps blood at an average rate of 5 L/min. The gauge pressure on the venous (intake) side is 0 mm Hg and that on the arterial (discharge) side is 100 mm Hg. Energy is supplied to the heart as heat released by the absorption of oxygen in the cardiac muscles: 5 mL (STP) O_2/min is absorbed, and 20.2 J is released per mL of O_2 absorbed. Part of this absorbed energy is converted to flow work (the work done to pump blood through the circulatory system), and the balance is lost as heat transferred to the tissues surrounding the heart. (20)

(i) Simplify the general energy balance equation for this system, assuming (among other things) that there is no change in internal energy from inlet to outlet.

(ii) What percentage of the heat input to the heart ($\dot{Q}_{in}$) is converted to flow work?

L-1/T-1/CHE **Date: 16/05/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **CHEM 111** (Inorganic Chemistry)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Use an example to explain the following statement "The Arrhenius acid-base model can be viewed as a part of the solvent system acid-base model". **(5)**

   (b) Identify the nature of product/products formed during a neutralization reaction according to Arrhenius. Bronsted Lowry, solvent and Lewis acid base theories. **(15)**

   (c) Use the hard-soft acid-base theory to explain the solubility trends down the group for silver and lithium halides. **(10)**

   (d) Apply Pearson's absolute Hardness scale to determine the nature of adducts. **(5)**

2. (a) How does molecular structure influences acid strength? **(5)**

   (b) Analyze the reaction mechanism between NH_3 and HF using molecular orbitals and restate the Lewis acid base theory accordingly. **(15)**

   (c) Carbon monoxide can act as a Lewis base — How? **(10)**

   (d) Water can act as an oxidizing and a reducing agent — explain using molecular orbital theory. **(5)**

3. (a) Define chelating ligand, co-ordination number and organometallic complex with example. **(5)**

   (b) An enzyme containing Ni^{2+} complex at the active site was found to be diamagnetic, predict the geometry of the complex using valence bond theory and crystal field theory. **(15)**

   (c) Discuss important types of isomerism in coordination complexes. **(10)**

   (d) Sketch structures of all isomers of $M(BB)_3$, in which BB is a bidentate symmetrical ligand. **(5)**

Contd P/2

4. (a) Compare the influence of pi donor and pi acceptor ligand on the color of a transition metal complex. **(5)**

(b) Using crystal field theory (CFT), explain the *d* orbital splitting in octahedral and tetrahedral fields. Describe how the crystal field splitting energy and crystal field stabilization energy will influence the color and magnetism of coordination complexes with six coordination number. **(15)**

(c) Define ligand field theory. Find out if the octahedral complex $[Co(H_2O)_6]^{3+}$ is high spin or low spin when ligand field splitting energy is 9350 cm^{-1} and average electron pairing energy is 17600 cm^{-1}. **(10)**

(d) Which among the complexes, $[Mn(PMe_3)(CH_3)_3]$ & $[Cr(NH_3)_5Cl]^{2+}$, does not follow the 18 electron rule? **(5)**

SECTION – B

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

5. (a) Explain the similarities and dissimilarities between Bohr model and Schrödinger model of an atom. **(10)**

(b) Calculate the wavelength (in meters) of the wave associated with a 1.00-kg mass moving at 1.00 km/hr. What is the wavelength (in picometers) associated with an electron, whose mass is 9.11×10^{-31} kg, traveling at a speed of 4.19×10^{6} m/s? **(10)**

(c) Draw orbital energy level diagram of (i) a single system (ii) a typical multi-electron system. Explain the reasons that account for the differences in these orbital energy level diagram patterns. **(15)**

6. (a) In the periodic table, the element hydrogen is sometimes grouped with the alkali metals and sometimes with the halogens. Explain why hydrogen can resemble the Group 1A and the Group 7A elements. **(8)**

(b) Why does transition elements form colored compounds? Explain. **(10)**

(c) General trend in any period of the main group elements is an increase in electron affinities from left to right, except group IIA and VA elements, which have smaller electron affinities than the preceding element. Explain why? **(9)**

(d) For the isolation of inert gas mixture from dry air: Nitrogen, oxygen, moisture and carbon dioxide of the air are removed by some reactions. Write down the reactions. **(8)**

Contd P/3

CHEM 111/CHE

7. (a) Draw Lewis structure and predict the geometry of the following compounds using VSEPR model: PCl_4^+, IF_5, XeF_4. **(9)**

(b) Bond strength of nitrogen molecule is greater than that of fluorine molecule. Explain using Molecular Orbital Theory (MOT) and molecular orbital diagram. **(20)**

(c) Why are the bond angles in methane, ammonia and water different even though central atoms of all of them have four electron pairs? **(6)**

8. (a) In molecular orbitals diagram, the energy of $\pi 2p$ orbital is lower than that of $\sigma 2p$ for B_2, C_2, and N_2. For O_2 and F_2 the energy of $\sigma 2p$ orbital is lower than the $\pi 2p$. Why does this happen? Explain with molecular orbital diagrams. **(20)**

(b) When light of frequency equal to 2.11×10^{15} s^{-1} shines on the surface of gold meal, the kinetic energy of ejected electrons is found to be 5.83×10^{-19} J. What is the work function of gold? **(10)**

(c) Give the equation that relates particle properties of light. Explain the meaning of each symbol in the equation. **(5)**

L-1/T-1/CHE **Date: 22/05/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **MATH 125** (Calculus)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Symbols used have their usual meaning.

1. (a) A function $f(x)$ is defined by $f(x)=\begin{cases} x^2 & when\, x\le 0 \\ x & when\, 0<x<1 \\ \frac{1}{x}, & when\, x\ge 1 \end{cases}$ **(10)**

Discuss the continuity and differentiability of the function at $x=0$ and $x=1$.

(b) Evaluate: **(15)**

(i) $\lim\limits_{x\to 0}\left(\frac{1}{x^2}-\frac{1}{\sin^2 x}\right)$

(ii) $\lim\limits_{x\to 0}\left(\frac{a^x+b^x}{2}\right)^{\frac{1}{x}}$

(c) Find the nth derivative of $y=\tan^{-1}\frac{\sqrt{1+x^2}-1}{x}$. **(10)**

2. (a) If $y=\sin\left(a\sin^{-1}x\right)$, then find $\left(1-x^2\right)y_{n+2}-(2n+1)xy_{n+1}+\left(a^2-n^2\right)y_n$. **(15)**

(b) If $u=\tan^{-1}\frac{x^3-y^3}{x-y}$, then show that $x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y}=\sin 2u$. **(10)**

(c) Verify that the hypotheses of Rolle's Theorem are satisfied for $f(x)=\frac{1}{2}x-\sqrt{x}$ on the interval [0, 4], and find all values of c in that interval that satisfy the conclusion of the theorem. **(10)**

3. (a) Find the relative extrema and inflection points of $f(x)=\frac{\ln x}{x}$. **(15)**

(b) Expand $\ln(\sin x)$ in powers of $(x-a)$. **(10)**

(c) Verify Euler's theorem when $u=x^3\ln\frac{y}{x}$ **(10)**

4. (a) Find the radius and height of the right circular cylinder of largest volume that can be inscribed in a right circular cone with radius 6 inches and height 10 inches. **(15)**

(b) Verify the mean value theorem for $f(x)=2x-x^2$ in the interval $(0,1)$. **(10)**

(c) Find the points on the curve $y=\frac{x}{1-x^2}$, where the tangent is inclined at an angle of $\frac{\pi}{4}$ to the x-axis. **(10)**

Contd P/2

MATH 125/CHE

SECTION – B

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

Symbols used have their usual meaning.

5. Work out the following:

(a) $\int \frac{dx}{x\sqrt{9x^2+4x+1}}$ **(12)**

(b) $\int e^{ax} \sinh bx \, dx$ **(11)**

(c) $\int \frac{dx}{3+2\sin x+\cos x}$ **(12)**

6. (a) Find a reduction formula for $I_n = \int \frac{dx}{(a+b\cos x)^n}$ and hence find $\int \frac{dx}{(1+\cos x)^3}$. **(12)**

(b) Evaluate $\lim_{n\to\infty}\left[\frac{1}{n}+\frac{\sqrt{n^2-1^2}}{n^2}+\ldots+\frac{\sqrt{n^2-(n-1)^2}}{n^2}\right]$. **(11)**

(c) Write down three general properties of definite integral. Hence evaluate the following integral by using the suitable properties of definite integral. **(12)**

$$\int_0^{\pi} x \ln(\sin x)\, dx$$

7. (a) Evaluate $\int_0^{\frac{\pi}{2}} \frac{dx}{1+4\cot^2 x}$. **(11)**

(b) Evaluate $\int_0^{\infty} \frac{x\,dx}{(x^2+a^2)(x^2+b^2)}$. **(12)**

(c) Show that, **(12)**

$$\int_0^{\frac{\pi}{2}} \frac{\sin^{2m-1}\theta \cos^{2n-1}\theta}{(a\sin^2\theta+b\cos^2\theta)^{m+n}} d\theta = \frac{1}{2}\frac{\Gamma(m)\Gamma(n)}{a^m b^n \Gamma(m+n)}.$$

8. (a) Find the area enclosed by the loop of the curve, $r = \sin 4\theta$. **(11)**

(b) Find the length of the arc of the parabola $y^2 = 4x$, which is intercepted between the points of intersection of the parabola and the straight line $3y = 8x$. **(12)**

(c) The base of a certain solid is the region enclosed by $y = \sqrt{x}, y = 0$, and $x = 4$. Every cross-section perpendicular to the x-axis is a semicircle with its diameter across the base. Find the volume of the solid. **(12)**

L-1/T-1/CHE **Date: 19/05/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **PHY 127** (Physical Optics, Waves & Oscillations and Modern Physics)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

1. (a) What are free and damped vibrations? **(7)**

   (b) Establish the differential equation of a damped harmonic oscillator and solve it for critically damped condition. **(18)**

   (c) Discuss the physical phenomena of aperiodic, critically damped and oscillatory conditions. **(10)**

2. (a) State forced vibrations. Mention a few examples of forced vibrations. **(7)**

   (b) A particle executing damped harmonic motion is subjected to an external periodic force. Solve the differential equation of the motion of the particle. Find out an expression for its maximum amplitude. **(18)**

   (c) A harmonic oscillator of quality factor 10 is subjected to a sinusoidal applied force of frequency one and a half times the natural frequency of the oscillator. If the damping is small, obtain the amplitude of the forced oscillation in terms of tis maximum amplitude. **(10)**

3. (a) State reverberation and reverberation time. **(7)**

   (b) Derive an expression for the rise of average sound energy per unit time according to Sabine's reverberation formula. **(18)**

   (c) The volume of a room is 1200 m^3. The area of wall, floor and ceiling are 200, 180 and 160 cm^2, respectively. The average absorption coefficient for walls, ceiling and floor are 0.04, 0.80 and 0.07. Calculate the average sound absorption coefficient and the reverberation time. **(10)**

4. (a) What is the physical significance of the results of Michelson-Morley experiment? **(7)**

   (b) Prove that the sum of two velocities never be greater than the velocity of light. **(18)**

Contd P/2

PHY 127

Contd... Q. No. 4

(c) Suppose a star is 15 light-years away from the Earth. How long it takes a spacecraft travelling at 0.9c to reach that star: **(10)**

(i) As measured by a stationary observer on the Earth?

(ii) As measured by an observer on the spacecraft?

(iii) What is the distance travelled according to an observer on the spacecraft?

SECTION – B

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

5. (a) (i) What are the difference between photoelectric effect and Compton effect? **(12)**

(ii) Explain the limitations of classical wave theory to explain the photoelectric effect.

(b) Briefly describe a photo-multiplier tube with schematic diagram. **(13)**

(c) If the maximum kinetic energy of an electron in a Compton scattering experiment is 10 KeV, what is the wavelength of the incident photon? **(10)**

6. (a) Describe liquid drop model of nucleus. **(15)**

(b) Which is better for power generation between nuclear fission and fusion? Explain you opinion. **(10)**

(c) Calculate the average life of $_{92}U^{235}$ radionuclide if its activity is known to decrease 5% per 200 Years. The decay product is non-radioactive. **(10)**

7. (a) Why are Newton's rings circular? Can you obtain a bright center in Newton's rings experiment? If the answer is yes, then discuss how? **(6)**

(b) Describe the interference method to determine the wavelength of light using Newton's rings. **(20)**

(c) In Newton's rings experiment, a plano-convex lens of the radius of curvature 4 m is placed on an optically flat glass plate and illuminated by monochromatic light. The diameter of the 7^{th} bright ring in the reflected system is 72×10^{-4} m. Calculate the wavelength of light. **(9)**

PHY 127

8. (a) Distinguish between Fresnel and Fraunhofer classes of diffraction. **(6)**

(b) What is Rayleigh's criterion of resolution? Find an expression for the resolving power of a telescope. **(20)**

(c) The aperture of a telescope is 3 *m*. The distance between the earth and the moon is 2.84×10^8 *m* and assume the mean wavelength of the moon's light as 500 *nm*. (9)

(i) What is the least distance between the two objects at the moon's surface that this telescope can resolve?

(ii) What is its resolving power?

(iii) If two telescopes having the diameter of the objective lens 3 *m* and 6 *m*, respectively, are considered, which will give higher resolving power? Justify your answer.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-I/T-I B. Sc. Engineering Examinations 2020-2021

Sub : **EEE 155** (Electrical Engineering Fundamentals)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) If the current $i(t)$ shown in Fig. for Q. 1(a) is passed through a 4 Ω resistor, find the average power absorbed by the resistor. **(17)**

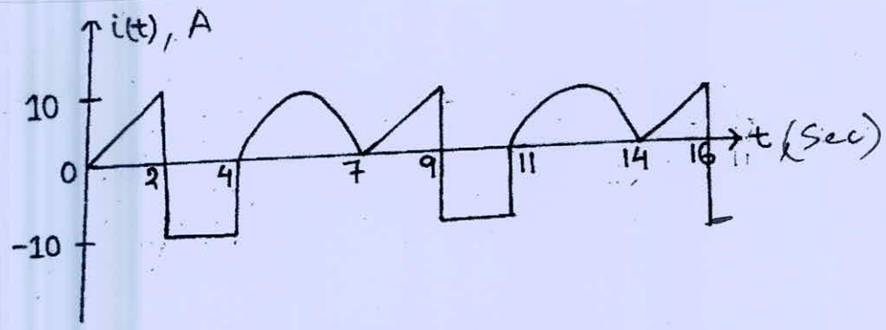

Fig. for Q. 1(a)

(b) In the circuit of Fig. for Q. 1(b), find the value of Z_L that will absorb the maximum power. Also find the value of the maximum power. **(18)**

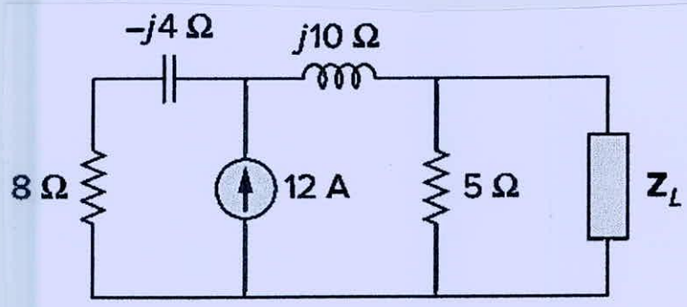

Fig. for Q. 1(b)

2. (a) Compute the nodal voltages V_1 and V_2 in the circuit of Fig. for Q. 2(a). **(15)**

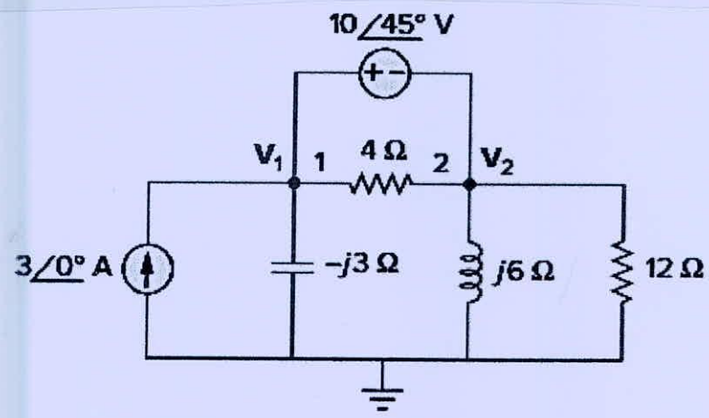

Fig. for Q. 2(a)

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EEE ~~101~~ 155

Contd... Q. No. 2

(b) Determine the value of current i_o in the circuit of Fig. for Q. 2(b). **(20)**

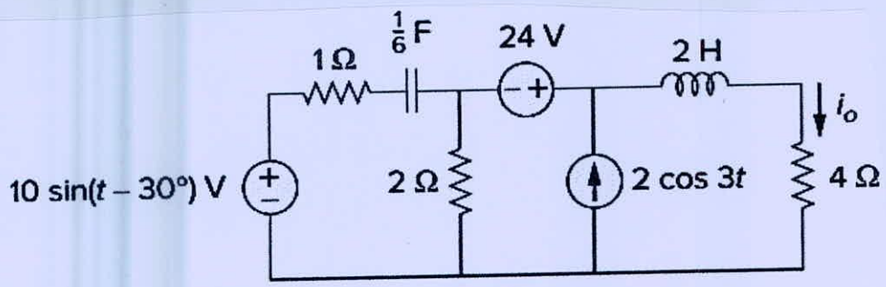


Fig. for Q. 2(b)

3. (a) Determine the equivalent impedance Z_T for the circuit given in Fig. for Q. 3(a). If a voltage source of $100\angle 0°$ volts is connected across terminals *a* and *b*, what will be the current leaving the source? Also find the amount of real and reactive power supplied by the source. **(17)**

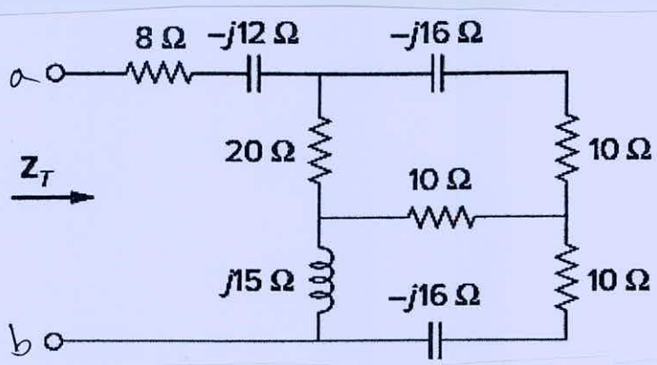


Fig. for Q. 3(a)

(b) For a series RLC circuit, **(18)**

(i) Derive the expression for impedance,

(ii) Derive the expression for instantaneous power,

(iii) Draw the phasor diagram for $X_L > X_C$ and $X_L < X_C$.

4. (a) Find the value of *I* required to establish a magnetic flux, $\varphi_2 = 1 \times 10^{-4}$ wb, as shown in Fig. for Q. 4(a). The sheet steel is laminated with a Stacking Factor of 0.9. Neglect fringing effect. B–H curve is attached. **(17)**

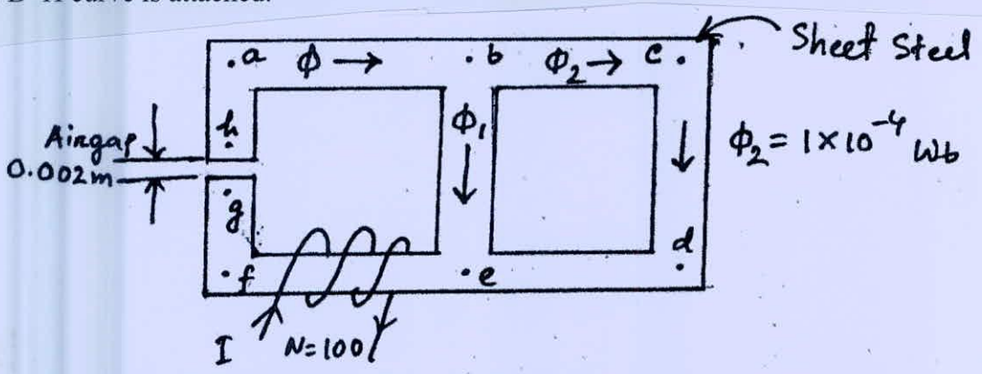
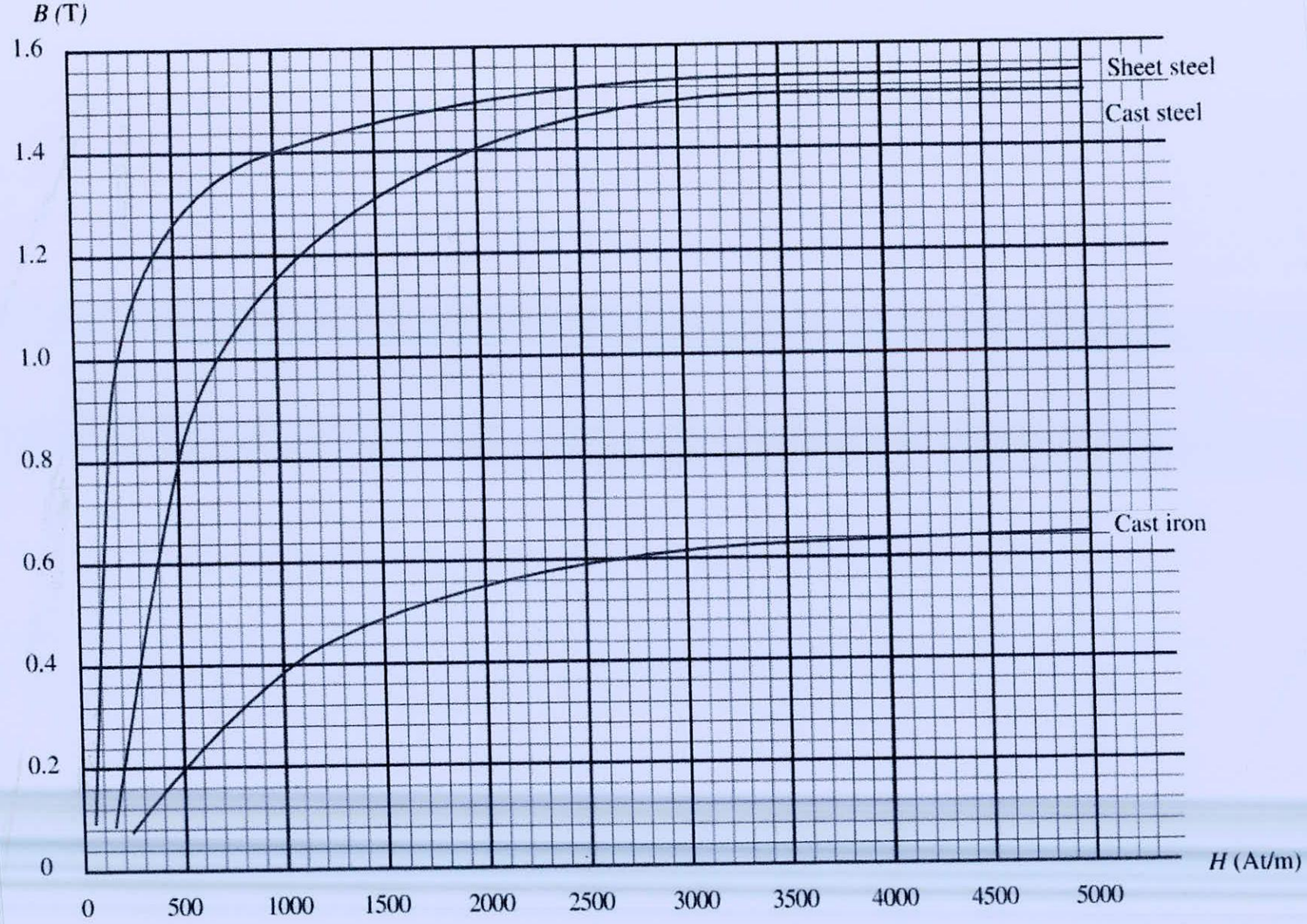


Fig. for Q. 4(a)



B-H curve for Q. No. 4(a)

Contd P/4

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Contd... Q. No. 4

(b) A 120-V rms 50-Hz source supplies two loads connected in parallel, as shown in Fig. for Q. 4(b).

(i) Find the power factor of the parallel combination.

(ii) Calculate the value of the capacitance connected in parallel that will raise the power factor to unity. **(18)**

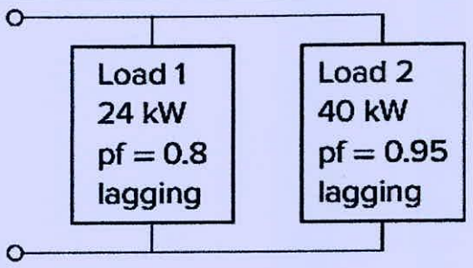

Fig. for Q. 4(b)

SECTION – B

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

5. (a) Find v_o and i_o in the circuit in Fig. for Q. No. 5(a). Also calculate the power supplied/consumed by each source. **(20)**

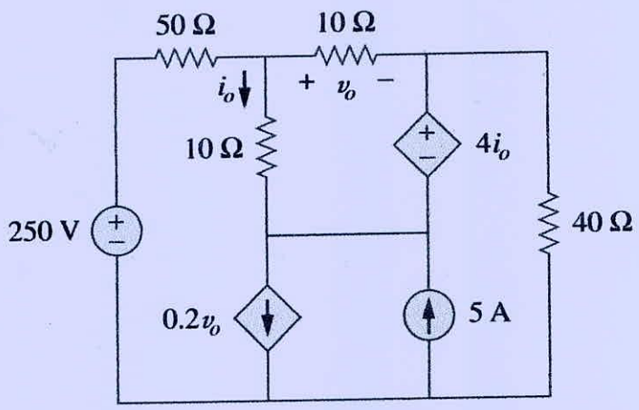

Fig. for Q. No. 5(a)

(b) Find the equivalent resistance at terminals a-b of the circuit shown in Fig. for Q. No. 5(b). **(15)**

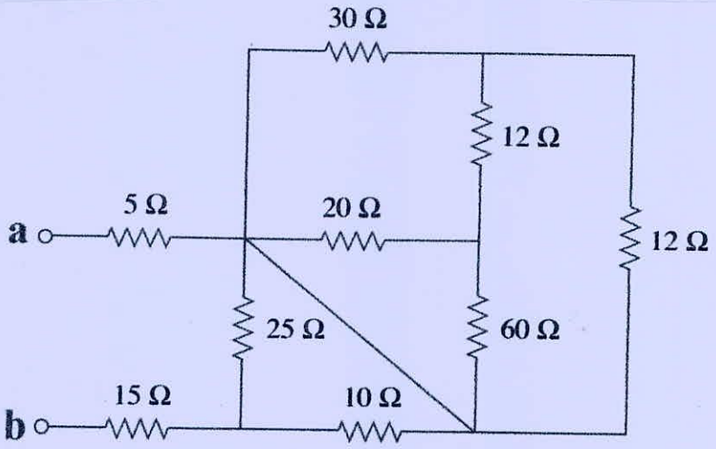

Fig. for Q. No. 5(b)

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6. (a) Use mesh analysis to determine i_o in the circuit of Fig. for Q. No. 6(a). **(18)**

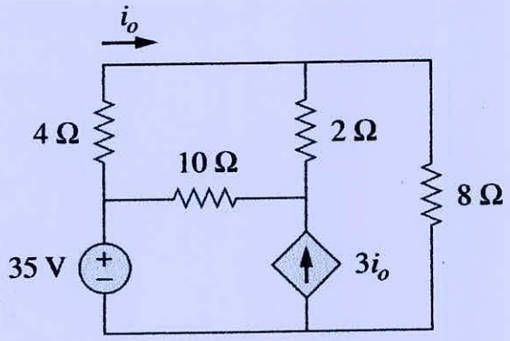

Fig. for Q. No. 6(a)

(b) Obtain v_o in the circuit of Fig. for Q. No. 6(b) using source transformation. **(17)**

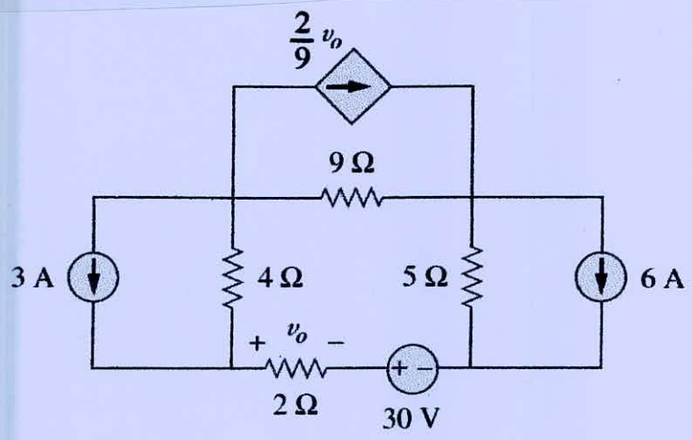

Fig. for Q. No. 6(b)

7. (a) Use superposition to find V_0 in the circuit of Fig. for Q. No. 7(a). **(18)**

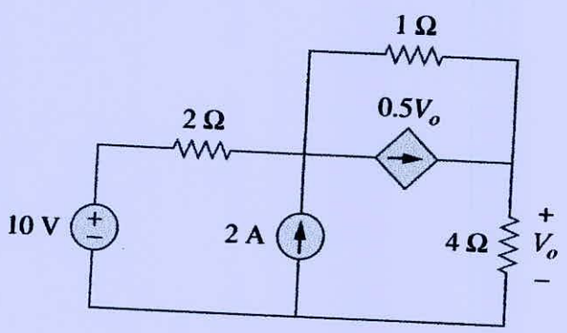

Fig. for Q. No. 7(a)

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(b) For the circuit shown in Fig. for Q. 7(b), Given that, I = 2 A when V_s = 20 V and I_s = 2 A and I = 5 A when V_s = 40 V and I_s = 12 A, determine- **(17)**

(i) the value of I when V_s = 60 volts and I_s = –2A

(ii) the value of R_1 and R_2.

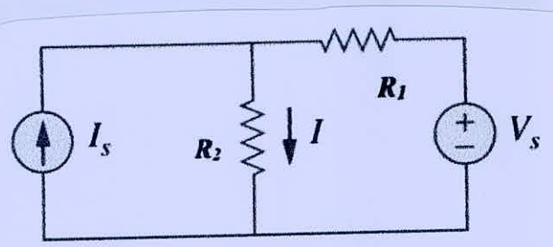

Fig. for Q. No. 7(b)

8. (a) Find the Thevenin equivalent of the circuit shown in Fig. for Q. 8(a) with respect to terminals a-b. What resistor connected across terminals a-b will absorb maximum power from the circuit? What is that power? **(20)**

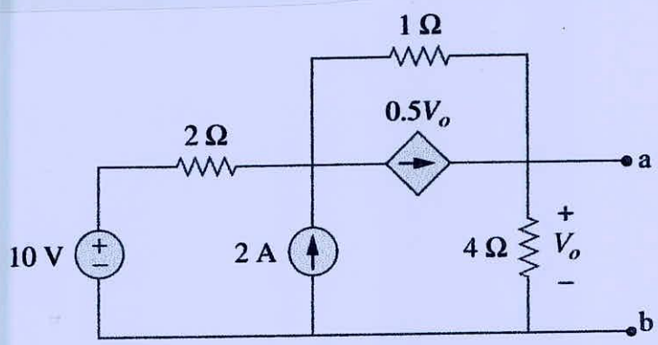

Fig. for Q. No. 8(a)

(b) The current passing through a circuit element is shown in Fig. for Q. No. 8(b). Express the charge (q) passing through the element as a function of time in 0 to 4 sec. Plot q vs. t. **(15)**

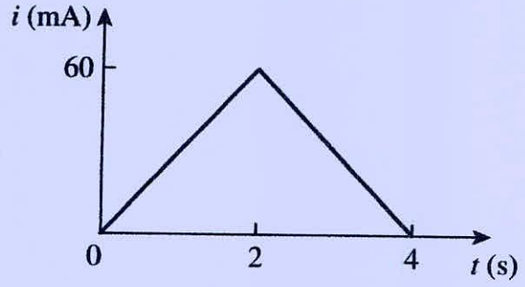

Fig. for Q. No. 8(b)
