

# National Institute of Technology Patna

Department of Mathematics

MID-SEM-EXAMINATION: MARCH, 2024

Course Name: **Engineering Mathematics II**

Course Code: MA28101

Program: B.Tech(Material Sc. and Engineering)

Full Marks:30

Duration: 2 Hrs.

**ANSWER ALL QUESTIONS IN DETAILS**

1. Evaluate  $\int \int_D x^2 y^2 dx dy$  where D is the circular disc  $x^2 + y^2 \leq 1$ . [5M]

2. Prove that the distribution function has minimum value zero and maximum value one. [5M]

3. A random variable X has a probability mass function given by  $P(X = 0) = 0.2$ ,  $P(X = 1) = 0.5$ ,  $P(X = 2) = 0.2$  and  $P(X = 3) = 0.1$ . Find the distribution function of X. [5M]

4. Find the value of the integral  $\int_0^{\frac{\pi}{2}} \sin^6 x \cos^8 x dx$ . [5M]

5. Evaluate  $I = \int \int \int_D xyz dx dy dz$  where D is the positive octant of the ellipsoid  $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ . [5M]

6. The probability density of a random variable X is  $2xe^{-x^2}$  for  $x > 0$  and zero otherwise. Find the probability density for  $X^2 + 2$ . [5M]

\*\*\*\*\*ALL THE BEST\*\*\*\*\*

# NATIONAL INSTITUTE OF TECHNOLOGY PATNA

Mid Semester Examination, Department of HSS

B.Tech.- M.Tech.-DD- MA- MCT / DD- PH- MSE/ DD-CH- CT

UG Dual Degree Sem. II, Session Jan- June 2023-2024

Science, Society and Ethical Values (HS27101/ HS28101/29101)

M.M. 30

**Note:** Attempt all question in maximum 250- 300 words each in one language only. Each question carries equal marks.

- ✓ What is the role of this subject (Science, Society and Ethical Values) in your life? Write your understanding about engineering ethics and environmental ethics.
- ✓ Establish a relationship between science and spirituality.
- ✓ Define Professional and discuss the responsibility of a professional towards the society.

**नोट:** सभी प्रश्नों को केवल एक भाषा में अधिकतम 250-300 शब्दों में हल करें।  
प्रत्येक प्रश्न के अंक समान हैं।

- आपके जीवन में इस विषय (विज्ञान, समाज और नैतिक मूल्य) की क्या भूमिका है? इंजीनियरिंग नैतिकता और पर्यावरण नैतिकता के बारे में अपनी समझ लिखें।
- विज्ञान और अध्यात्म के बीच संबंध स्थापित करें।
- पेशेवर को परिभाषित करें और समाज के प्रति एक पेशेवर की जिम्मेदारी पर चर्चा करें।

**Department of Physics**  
**National Institute of Technology Patna**

Course: DD-MSE

Time: 2 hours  
Total Marks: 30

**PH28101 Kinetics and Thermodynamics**

- 1 What do you mean by heat capacity? The heat capacity of 0.125 kg of water is measured to be  $523 \text{ JK}^{-1}$  at room temperature. Hence calculate the heat of water (a) per unit mass and (b) per unit volume. [2]
- 2 State the first law of thermodynamics. Calculate the heat capacity of an ideal monoatomic gas. [2]
- 3 Calculate the heat change for a reversible isothermal expansion of an ideal gas. [3]
- 4 Find the work done when (i) 1 g of  $\text{O}_2$  at NTP and (ii) 1 g of He at NTP are respectively adiabatically compressed to half its volume and double its pressure. Given  $\gamma = 1.40$  and  $R = 8.3 \times 10^7 \text{ erg}/\text{C}^\circ/\text{mol}$  [4]
- 5 State the Claussius' and Kelvin's statement of the second law of thermodynamics. [2]
- 6 By revisiting the first law of thermodynamics with the concept of entropy prove that  $\frac{p}{T} = (\frac{\partial S}{\partial V})_U$  [2]
- 7 Find the expression for  $Q_h/Q_l$  for an ideal gas undergoing a Carnot cycle in terms of the temperatures  $T_h$  and  $T_l$ . [3]
- 8 Considering an irreversible process such as Joule expansion, derive the expression for the change in entropy. In this context explain the concept of the concept of 'Maxwell's Demon'. [3]
- 9 10 g of steam at  $100^\circ\text{C}$  is blown on the surface of 90 g of water at  $0^\circ\text{C}$ , contained in a calorimeter of water equivalent 10 g, all steam being condensed. Calculate the increase in entropy of the system. [4]
- 10 Two bodies of equal and constant thermal capacity C, and at absolute temperatures  $T_1$  and  $T_2$  ( $T_1 > T_2$ ) respectively attain the same temperature on being placed in direct thermal contact. Show the loss of available energy is  $T_0 C \ln \frac{(T_1 + T_2)}{4T_1 T_2}$ , where  $T_0$  is the lowest available temperature [5]



**NATIONAL INSTITUTE OF TECHNOLOGY, PATNA**  
**MID-SEMESTER EXAMINATION, JAN - JUN 2024**

**Program: B.Tech; Semester: 2<sup>nd</sup>**  
**Course Code: CH27101, CH28101, CH29101**  
**Full Marks: 30**

**Department: MCT, MSE & CT**  
**Course Name: Engineering Chemistry**  
**Duration of Examination: 2 hours**

**All questions are compulsory & in accordance to NEP 2020**

<b>Q1</b>	Discuss the factors affecting the magnitude of CFSE in coordination complexes of transition metal?	02	CO3
<b>Q2</b>	a) What is the typical reagent for diazotization reaction? Show the formation of effective electrophile. b) How to obtain the 4-iodo-nitrobenzene from 4-nitroaniline? Explain with detailed mechanism. c) Can we obtain iodobenzene from aniline using exactly the same synthetic pathways?	1+2 +1 = 04	CO4
<b>Q3</b>	a) What comprises a typical nitrating mixture? b) Is it different from the nitrating reagent employed for nitration of naphthalene? Which one is a harsher condition? c) What are the possible products formed upon nitration of naphthalene? d) Which one is expected to be formed in overwhelming amount and why? e) Identify and reason out the kinetically (KCP) and thermodynamically controlled products (TCP). f) What is the color of nitronaphthalene and why at all there is a change in the color of naphthalene?	1+1 +1+ 1+1 +1 = 06	CO4
<b>Q4</b>	a) Name the oxidant and indicator employed for estimation of Fe(II) in Mohr's salt in presence of 1M acid solution. What is the color change at the equivalence point? b) Identify the redox couples. Describe the respective half-cell reactions and the overall reactions. c) Write the Nernst expression for each half-cell. Derive the expression for $E_{cell}$ at the equivalence point. d) What are the two purposes of adding $H_3PO_4$ during this titration? Draw a typical titration curve with EMF vs volume of titrant added.	1+1 +2+ 2 = 06	CO2

Q5	<p>a) What are primary and secondary standard solutions? Name the primary and secondary standard solutions employed for the estimation of Cu(I) in an unknown solution.</p> <p>b) What is the difference between iodometry and iodimetric titrations? Which one has been employed in the above case?</p> <p>c) What is formal potential? The standard reduction potential values of <math>\text{Cu}^{2+}/\text{Cu}^+</math> and <math>\text{I}_2/\text{I}^-</math> are 0.15 V and 0.54 V. How is it possible to reduce <math>\text{Cu}^{2+}</math> to <math>\text{Cu}^+</math> under the prevailing conditions? Explain with Nernst expression.</p>	$2+2$ $+2 =$ $06$	CO2
Q6	<p>a) Draw the reagents employed in the complexometric titration of hard metal ions for estimation of hardness of water? Which reagent in particular forms a chelate?</p> <p>b) Draw the geometry for metal chelate complex.</p> <p>c) Why a pH range of 8-10 is ideal for the stability of the hard metal chelate complex? Why lower and higher pH values are detrimental for the stability of this complex?</p> <p>d) Name the chemical species responsible for permanent and temporary hardness? How do you remove temporary hardness?</p>	$1+1$ $+2+$ $2 =$ $06$	CO3



National Institute of Technology Patna  
Department of Electrical Engineering  
Elements of Electrical Engineering (EE27101, EE28101, EE29101)  
Mid Term, Date: 14 March, 2024

Timing: 02:00 PM to 04:00 PM

Jan-June 2024

Max mark: 20

1. A battery having an e.m.f. of 105 V and an internal resistance of  $1\Omega$  is connected in parallel with a D.C. generator of e.m.f. 110 V and an internal resistance of  $0.5\Omega$  to supply a load having a resistance of  $8\Omega$ . Calculate

(a) The currents in the battery, the generator and the load;

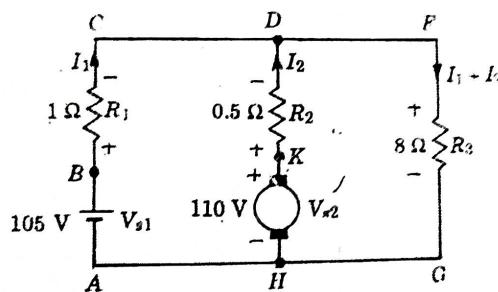


Figure 1: Network for Q1 (a)

(b) the potential difference across the load. (5)

2. Four resistance AB, BC, AD and DC are connected together to form a closed square ABCD. The known resistance value are; AD =  $12\Omega$  AB =  $35\Omega$  and DC =  $12\Omega$ . A D.C. supply of 120 V is connected to A and C so that the current enters the combination at A and leaves at C. A high-resistance voltmeter is connected between B and D, and whilst carrying negligible current, registers a voltage drop of 10 V from B to D.

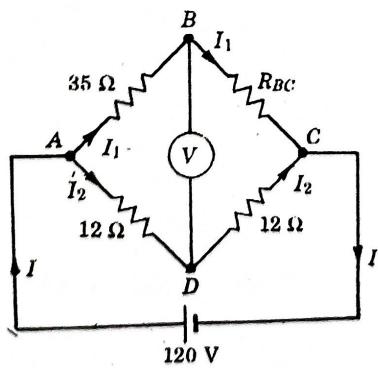


Figure 2: Network for Q2

- (a) Calculate the value of resistance BC, and the total current taken from the supply.

- (b) Calculate the value of BC, such that the potential difference between B and D is in the reverse direction, i.e. from D to B (C& G). (5)

3. (a) Find the resistance between the terminals a-b of the bridge circuit shown in Figure 3 by using delta-star transformation. (5)

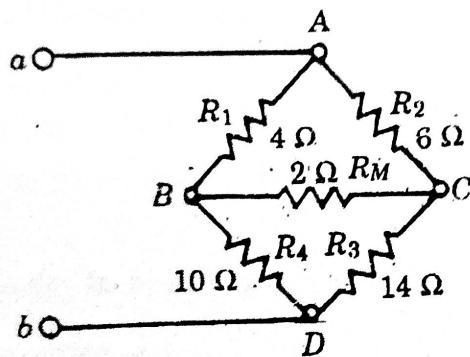


Figure 3: Network for Q3 (a)

- (b) State Superposition Theorem. Determine the current  $I$  in the network shown in Figure 4 by the principle of superposition. (5)

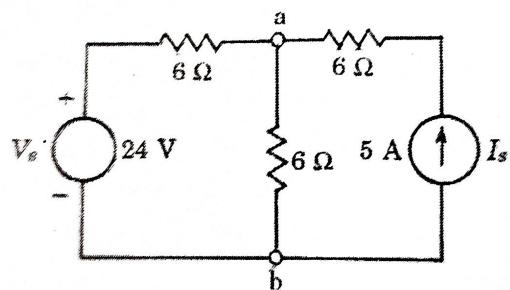


Figure 4: Network for Q3 (b)