



ST. XAVIER'S COLLEGE

Maitighar, Kathmandu

B.Sc. Physics 2nd Year

Mid-Term Examination 2024

Subject: Physics (Phy. 201)

Full Marks: 100

Time: 3 hrs

Pass Marks: 40

Candidates are required to give their answers in their own words as far as practicable. The figures in the margin indicate full marks.

Attempt All Questions

1. What are the cardinal points? Explain how spherical and chromatic aberrations are minimized in Huygens's eye piece? [10]

OR

What is interference of light? Prove that the distance β between two successive dark and bright fringes formed in Young's experiment is given by $\beta = \frac{D\lambda}{d}$.

2. What is Compton Effect? Deduce an expression for the change in wavelength of the scattered wave. Show that the change in wavelength is independent of the wavelength of the incident ray but depends on the scattering angle. [1+7+2]

OR

State the postulates of Bohr regarding atom model. Obtain expressions for the radius and energy of an electron in the n th orbit. Explain how Bohr's atom model successfully accounts for the hydrogen atom. [3+5+2]

3. Draw the circuit diagram of CE-amplifier. Calculate its voltage gain, current gain and power gain. Explain why there is phase inversion between the input and output. [10]

OR

What are the basic differences between Norton's and Thevenin's network theorem? Explain one of them with an example of your own. [10]

4. Describe the vector model of the atom and explain the different quantum numbers associated with it. [8]

5. Distinguish between polarized and unpolarized light. State and explain Brewster's law. [8]

6. Draw a circuit diagram of a bridge rectifier and explain its action. Describe the action of a capacitor input filter in smoothing out the ac component and its ripple factor. [8]

7. Solve any TWO questions [2 × 3 = 6]

a) Explain Mosely's law and its importance.

b) Explain the phenomenon of pair production.

c) Explain about Quiescent point.

d) Why Ramsden's eye piece is more preferable than Huygen's eye piece?

8. Solve All questions

[4 × 2.5 = 10]

a) Define the terms: Critical potential, Excitation potential and Ionization potential.

b) Explain the fine structure of X-rays.

c) Show that the power transfer will be maximum if the source and load impedance are conjugate of each other.

d) Explain the difference optical path and geometrical path.

9. The wavelength of the L_α line of X-rays in the case of Platinum [$Z=78$] is 1.321 \AA . An unknown substance emits L_α of wavelength 4.174 \AA . Calculate the wavelength when it is scattered through 180° . [Given: $b=7.4$]

[5]

10. Two thin lenses of focal lengths f_1 and f_2 separated by a distance d have an equivalent focal length 50 cm ; the combination satisfies the conditions for no chromatic aberration and minimum spherical aberration. Find the values of f_1 , f_2 and d , assume that both of lenses are of the same materials.

[5]

11. In a Newton's ring experiment the diameter of the 15^{th} dark ring was found to be 0.590 cm and that of the 5^{th} ring was 0.336 cm . If the radius of the Plano-convex lens is 100 cm , calculate the wavelength of the light used.

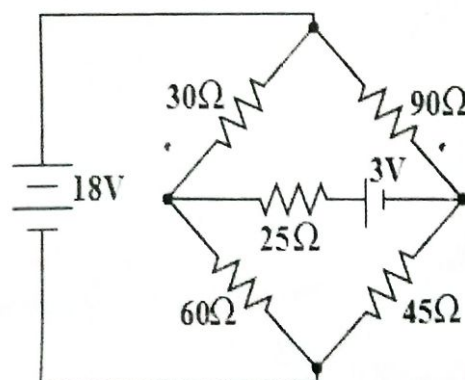
[5]

12. A beam of silver atoms (atomic weight = 108) in a Stern-Gerlach experiment, obtained from an oven heated to a temperature of 1500 K , enters an inhomogeneous magnetic field perpendicular to the beam with a velocity of 10^4 m/s . If the length of the field is 10 cm and gradient of field is 10^2 Tesla/meter , calculate the separation between the two components of the beam on a photographic plate assuming that the magnetic moment of silver atoms is only due to spin motion of electron.

[5]

13. Use the Thevenin's method for finding the current in the 25Ω resistor

[5]



14. A power supply provides 100 mA at 20 V dc . It uses a shunt capacitor filter & is driven from a 50 Hz source. Calculate the ripple factor for full wave rectification [when $C = 100 \mu\text{F}$].



ST. XAVIER'S COLLEGE

Maitighar, Kathmandu

B.Sc. Physics 2nd Year

Mid-Term Examination 2024

Subject: Applied Statistics (STA201)

Time: 1.5 hrs

Full Marks: 50

Pass Marks: 20

Candidates are required to give their answers in their own words as far as practicable. The figures in the margin indicate full marks.

Attempt all questions

Group 'A'

[6×5=30]

1. Define primary and secondary data and distinguish between them.
2. What is meant by 'Measures of central tendency'? Consider the following frequency tabulation of leaf (in grams)

x	1.85-1.95	1.95-2.05	2.05-2.15	2.15-2.25	2.25-2.35
f	5	4	10	7	4

Calculate the mean and standard deviation of leaf weight.

3. The average of 200 students of Private Campuses within Valley is observed to be 70 with S.D. 30 and the average score of 300 students of constituent campus is observed to be 60 with S.D. 30. What is the combined average and combined standard deviation?

4. Compute percentile coefficient of Kurtosis from following data and interpret the result.

Hourly wages (Rs)	23-27	28-32	33-37	38-42	43-47	48-52
No. of workers	22	16	9	4	3	1

5. A person while calculating the correlation coefficient between the variables X and Y obtained the following results $n=30$, $\sum X=120$, $\sum X^2=600$, $\sum Y=90$, $\sum Y^2=250$, $\sum XY=356$. It was, however, later discovered at the time of checking that it had copied down two pairs of observations as: (8, 10) and (12, 7) while correct values were (8, 12) and (10, 8).

Obtain the correct values of correlation coefficient between them.

6. Differentiate between point and interval estimation. 400 oranges are taken from a large, consignment and 50 of them are found to be bad. Estimate the percentage of the bad oranges in the consignment and assign 95% limits within which the percentage lies.

Group 'B'

Attempt all questions.

[2×10=20]

7. In the competition to draw the tallest holly book, the heights were recorded by 60 primary schools. Children heights measured in the nearest centimeter were as follows:

Height in cm	177-186	187-191	192-196	197-201	202-206	207-216
Frequency	15	10	10	12	6	7

- i. Draw a histogram and frequency polygon.
- ii. Compute Karl Pearson's coefficient of skewness and interpret the result.

$$3(\bar{x} - m_d)$$



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Mid-Term Examination 2024

Subject: Linear Algebra (MAT 201)

Full Marks: 75

8. The following data show the retail price for 8 randomly selected laptop computers along with their corresponding processor speed in gigahertz.

Computer	1	2	3	4	5	6	7	8
Speed	2.0	1.6	1.6	1.8	2.0	1.2	1.2	1.6
Price in '00000' Rs.	2.2	1.8	1.7	1.0	2.3	1.1	1.0	1.7

i. Compute the correlation coefficient between the processor speed and the price of the computer.

ii. Develop a linear equation that can be used to describe how the price depends on the processor speed.

iii. Interpret the value of the y-intercept and slope of the line.

iv. Estimate the price of a laptop whose processor speed is 1.5 gigahertz.



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B.Sc. Physics 2nd Year

Mid-Term Examination 2024

Subject: Linear Algebra (MAT 201)

Time: 3 hrs

Full Marks: 75

Pass Marks: 30

Candidates are required to give their answers in their own words as far as practicable. The figures in the margin indicate full marks.

Group A (5X8=40)

1. What do you mean by the consistent and inconsistent equations? Test the consistency and solve the system by reduced row Echelon form

$$x + y + z = 2; 3x - 4z = -7; 2x - y + 7z = 15. \quad 1/3, -1/3, 2$$

2. Prove that every square matrix can be uniquely expressed as the sum of a symmetric matrix and a skew-symmetric matrix.

3. Define kernel of a matrix. Prove that if \mathbf{u} is a vector such that $A\mathbf{u} = \mathbf{b}$, then every solution of the equation $A\mathbf{x} = \mathbf{b}$ is of the form $\mathbf{x} = \mathbf{u} + \mathbf{z}$ for some vector \mathbf{z} in $\text{Ker}(A)$. Solve the system of following linear equations: $x + 2y + 3z = 20, 4x + 5y + 6z = 47, 7x + 8y + 9z = 74, 10x + 11y + 12z = 101$.

4. Prove that the counterclockwise rotation of every point in \mathbb{R}^2 by an angle ϕ is a linear transformation whose matrix is $\begin{bmatrix} \cos\phi & -\sin\phi \\ \sin\phi & \cos\phi \end{bmatrix}$. Find the image of a point $(1, 2)$ under the rotation of angle $\phi = \frac{\pi}{6}$.

5. Explain the Gauss Jordan Method. Apply Gauss Jordan method to solve the system of equations.

$$x + y + z = 9, 2x - 3y + 4z = 13, 3x + 4y + 5z = 40$$

$$-2/5, -29/5, 18/5$$

Group B (5X7=35)

6. Find the product of two matrices $A = \begin{bmatrix} 3 & 2 \\ 1 & 4 \\ 0 & -1 \end{bmatrix}$, $B = \begin{bmatrix} 1 & 3 \\ 2 & 1 \end{bmatrix}$ by pre-multiplication method. Also what is

the $(3, 2)$ element in the product of matrix $A = \begin{bmatrix} 1 & 4 & 3 & 2 \\ 2 & 0 & -3 & 5 \\ -3 & 5 & 7 & 1 \end{bmatrix}$ and

$$\text{Matrix } B = \begin{bmatrix} 3 & 5 & 4 \\ -4 & 1 & 11 \\ 2 & -5 & 1 \\ 3 & -7 & 6 \end{bmatrix}. \text{ That is what is } (AB)_{32}.$$

7. Define inverse of a square matrix. Prove that $(A^T)^{-1} = (A^{-1})^T$ i.e. inverse of transpose of matrix is transpose of its inverse. Also verify it for matrix (give example).

8. Define rank of a matrix. Find the rank of the matrix $A = \begin{bmatrix} 1 & 4 & 3 & 2 \\ 2 & 0 & -3 & 5 \\ -3 & 5 & 7 & 1 \end{bmatrix}$. Prove that the rank of a matrix form a linearly dependent set if and only if there is a zero row in any row echelon form of that matrix.

9. Define linear transformation. Let $T: \mathbb{R}^n \rightarrow \mathbb{R}^m$ be a linear transformation. Then prove that there exists a matrix $A = [a_{ij}]_{m \times n}$ such that $T(\mathbf{x}) = A\mathbf{x}$ for all $\mathbf{x} \in \mathbb{R}^n$. Let $T: \mathbb{R}^2 \rightarrow \mathbb{R}$ be a linear transformation for which $T(1, 1) = 3$ and $T(0, 1) = -2$. Then find the value of $T(1, \frac{1}{2})$.

10. Define Eigen value and Eigen vector. The scalar λ is the Eigen value of the matrix A if and only if $|A - \lambda I| = 0$. Find the Eigen value and the Eigen vector of the matrix $\begin{bmatrix} 5 & 2 \\ -1 & 2 \end{bmatrix}$.



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B.Sc. Physics 2nd Year

Mid-Term Examination 2024

Subject: Probability Inference (APS 201)

Time: 3 hrs

Full Marks: 100

Pass Marks: 40

Candidates are required to give their answers in their own words as far as practicable. The figures in the margin indicate full marks.

Attempt all questions.

Group A(Probability) (5x10=50)

1. Given the following Bi-variate probability distribution.

Y \ X	-1	0	1
0	1/15	2/15	1/15
1	3/15	2/15	1/15
2	2/15	1/15	2/15

- Obtain
- Marginal probability mass function of X and Y.
 - Conditional distribution of X given $y = 1$ and Y given $x = 2$.
 - $E(X)$, $E(X^2)$ and $V(X)$

2. Define simple random sampling. Show that in case of SRSWOR, the variance of the sample mean is given by

$$\text{Var}(\bar{x}) = \left(\frac{N-n}{N}\right) S^2/n$$

Where signs and symbols have their own meaning.

3. Define simple random sampling. The sex ratio at birth is sometimes given by the ratio of male to female births instead of the population of male to total births. If Z is the sex ratio i.e., $Z = p/q$, show that the standard error of Z is approximately equal to $\frac{1}{1+Z} \sqrt{Z/n}$; n being large shows that deviations are small compared with mean.

4. Define conditional expectation and variance of X given Y. Let X and Y be jointly distributed random variables with probability function $p(x,y)$ or $f(x,y)$, then the expectation of the conditional variance of X given $Y=y$ and variance of conditional expectation of X given $Y=y$ is equal to variance of X.

5. If $F \sim F_{(6,8)}$, $P(F_{(6,8)} > 3.58) = 0.05$ then find $P(F_{(8,6)} > \frac{1}{3.58})$.

Obtain mean and variance of F distribution with (m, n) degree of freedom.

Group B (Inference) (5x10=50)

6. State and prove Cramer-Rao inequality.
 7. Define the method of likelihood estimation. For exponential distribution with probability density function (pdf)

8. $f(x, \theta) = \theta e^{-\theta x}$, $x > 0$, $\theta > 0$. Find the MLE of parameter θ .

Differentiate between point and interval estimation with examples. Let x_1, x_2, \dots, x_n be a random sample of large size n from an exponential distribution with probability density function: $f(x, \theta) = \frac{1}{\theta} e^{-\frac{x}{\theta}}$; $0 < x < \infty$, $\theta > 0$

Obtain a $100(1-\alpha)\%$ confidence interval for θ .

9. a) The following sample values x_i and y_j of the two independent random samples so that $x_i \sim N(\mu_1, \sigma^2)$ and $y_j \sim N(\mu_2, \sigma^2)$:

x_i	28	30	32	33	33	29	34
y_j	29	30	30	24	27	29	

Obtain a 98% confidence interval for $\mu_1 - \mu_2$

b) A random sample of 300 students from Campus A showed that 125 students were smokers. Another random sample of 500 students from Campus B showed that 160 students were smokers. Find a 90% confidence interval for true difference between two population proportions.

10. Define null and alternative hypotheses. If $0.5 \leq x$ is the critical region for testing $H_0: \theta = 1$ against $H_1: \theta = 2$ based on single observation from a population with density function:

$$f(x, \theta) = \frac{1}{\theta}, 0 \leq x \leq \theta$$

$$= 0, \text{ elsewhere}$$

Obtain the probabilities of type I and type II errors.