APPLIED MATHEMATICS

Maximum Marks: 80
Time Allotted: Three Hours
Reading Time: Additional Fifteen Minutes

Instructions to Candidates

1. You are allowed an **additional fifteen minutes** for **only** reading the paper.
2. You must **NOT** start writing during reading time.
3. The question paper has **thirteen printed pages**.
4. It consists of **20 questions and four sections: A, B, C and D**. **All questions are compulsory.**
5. **Section A** comprises **very short answer questions** of **1 mark** each.
6. **Section B** consists of **short answer questions** of **2 marks** each.
7. **Section C** consists of **moderately long answer questions** of **3 marks** each.
8. **Section D** consists of **long answer questions** of **5 marks** each.
9. Internal choices have been provided in **three** questions, each in **Sections B, C and D.**
10. While attempting **Multiple Choice Questions in Section A**, you are required to **write only ONE option as the answer.**
11. The intended marks for questions or parts of questions are given in the brackets [].
12. All workings, including rough work, should be done on the same page as, and adjacent to, the rest of the answer.
13. Mathematical tables and graph papers are provided.

Instruction to Supervising Examiner

1. Kindly read aloud the instructions given above to all the candidates present in the examination hall.

Note: The Specimen Question Paper in the subject provides a realistic format of the Board Examination Question Paper and should be used as a practice tool. The questions for the Board Examination can be set from any part of the syllabus, though the format of the Board Examination Question Paper will remain the same as that of the Specimen Question Paper. The weightage allocated to various topics, as given in the syllabus, will be strictly adhered to.

SECTION A – 20 MARKS

Question 1

In subparts (i) to (xvii) choose the correct options and in subparts (xviii) to (xx), answer the questions as instructed.

(i) In a class of 60 Students, 25 play cricket, 20 play tennis and 10 students play both the games. The number of students who play neither of the games is: **[1]**

(Application)

(a) 10

(b) 55

(c) 5

(d) 25

(ii) Identify the least positive integral value of 'n' for which $\left(\frac{1+i}{1-i}\right)^n$ is real. **[1]**

(Application)

(a) 0

(b) 1

(c) 2

(d) -1

(iii) Consider the parabola $3x^2 = -8y$ **[1]**

Statement I: The equation of the directrix of the given parabola is $3y + 2 = 0$.

Statement II: The equation of the latus rectum of the given parabola is $3y - 2 = 0$.

Which one of the following is correct about the above statements?

(Understanding)

(a) Both the statements are true.

(b) Both the statements are false.

(c) Statement I is true and Statement II is false.

(d) Statements I is false and Statement II is true.

(iv) There are 5 items in Column A and 5 items in Column B. The number of ways in which each item in Column A matches with a unique item in Column B is: **[1]**

(Understanding)

(a) 120

(b) 10

(c) 5

(d) 20

(v) A and B are two mutually exclusive events of an experiment. If P (not A) = 0·57 and P (either A or B) = 0·74 and P(B) = q, then the value of q is: **[1]**

(Application)

(a) 0·17

(b) 0·31

(c) 0·69

(d) 0·36

(vi) The amount of money today which is equal to series of payment in future is: **[1]**

(Recall)

(a) sinking value of annuity.

(b) nominal value of annuity.

(c) present value of annuity.

(d) future value of annuity.

(vii) **Assertion:** In a negatively skewed distribution, the mean is less than the median and the median is less than the mode. **[1]**

Reason: In a negatively skewed distribution, the tail of the distribution extends towards the negative side, indicating that most values are clustered towards the higher end of the scale.

Choose the correct answer from the following options. **(Understanding)**

(a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion

(b) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion

(c) Assertion is true and Reason is false.

(d) Assertion is false and Reason is true.

(viii) Considering the following statements. **[1]**

Statement I: CGST input tax credit cannot be claimed against IGST output tax liability.

Statement II: SGST input tax credit cannot be claimed against IGST output tax liability

Which one of the following is correct about the above statements? **(Recall)**

(a) Both the statements are true.

(b) Both the statements are false.

(c) Statement I is true and Statement II is false.

(d) Statements I is false and Statement II is true.

(ix) The middle term in the expansion of $\left(\frac{2x^2}{3}+\frac{3}{2x^2}\right)^{10}$ is: **(Application)** **[1]**

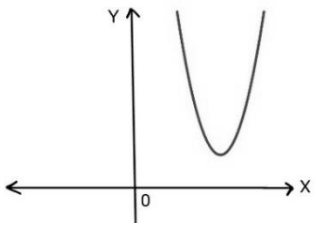
(a) 250

(b) 251

(c) 252

(d) 242

(x) Choose the suitable equation for the given curve: **(Analysis)** **[1]**



(a) $y = ax^2 + bx + c, a < 0 \; and \; D < 0$

(b) $y = ax^2 + bx + c, a > 0 \; and \; D < 0$

(c) $y = ax^2 + bx + c, a < 0 \; and \; D > 0$

(d) $y = ax^2 + bx + c, a > 0 \; and \; D > 0$

(xi) The value of $\lim_{x\to 3}\frac{x^5-3^5}{x-3}+\lim_{x\to 0}e^x$ is: **(Understanding)** **[1]**

(a) 405

(b) 406

(c) 1

(d) 0

(xii) The value of $3^{\frac{1}{3}} \times 3^{\frac{1}{9}} \times 3^{\frac{1}{27}} \times \ldots\ldots\ldots\ldots\ldots$ upto infinite terms is: **[1]**

(Understanding)

(a) 3

(b) $\sqrt{3}$

(c) 9

(d) ∞

(xiii) The algebraic equation of $2logx + 3logy - logz = log3$ is: **(Understanding)** **[1]**

(a) $\frac{6xy}{z} = 3$

(b) $x^2 + y^3 - z = 3$

(c) $\frac{x^2}{y^3} = \frac{3}{z}$

(d) $x^2y^3 = 3z$

(xiv) Let a, b, c are in Arithmetic Progression. A_1 is the arithmetic mean between a and b. A_2 is the arithmetic mean between b and c. The arithmetic mean between A_1 *and* A_2 is: **[1]** **(Application)**

(a) b

(b) $2b$

(c) $\frac{b}{2}$

(d) b^2

(xv) The multiplicative inverse of $3 + 2i$ is: **(Understanding)** **[1]**

(a) 3 – 2i

(b) $\frac{3 + 2i}{13}$

(c) $\frac{3 - 2i}{13}$

(d) $\frac{3 - 2i}{9}$

(xvi) **Assertion:** If ${}^nC_{12} = {}^nC_8$ then $n = 20$ **[1]**

Reason: ${}^nC_r = {}^nC_{n-r}$ **(Understanding)**

Choose the correct option.

(a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.

(c) Assertion is true and Reason is false.

(d) Assertion is false and Reason is true.

(xvii) The quadratic equation with $3 + \sqrt{2}$ i as one of the roots is: **(Understanding)** **[1]**

(a) $x^2 + 6x + 7 = 0$

(b) $x^2 - 6x + 7 = 0$

(c) $x^2 - 6x + 5 = 0$

(d) $x^2 + 6x + 5 = 0$

(xviii) In a code language TAPE is written as 4825, SMART is written as 91834 and BONE is written as 7605, then what is the code language for BASERA? **[1]**

(Application)

(xix) Find the angle in radian through which a pendulum swings if its length is 75 cm and the tip describes an arc of length 21 cm. **[1]** **(Application)**

(xx) What is the acute angle between the lines x + y = 0 and y = 0? **(Understanding)** **[1]**

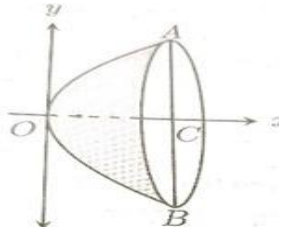
SECTION B – 14 MARKS

Question 2 **[2]**

A committee of 4 persons is to be created from a group of 6 men and 7 women. If the selection is made randomly, find the probability that there are equal numbers of men and women in the committee. **(Application)**

Question 3 **[2]**

If a parabolic reflector is 20cm in diameter and 5cm deep. Find the coordinates of its focus. **(Application)**



Question 4 **[2]**

If a relation $R = \{(0,0), (2,4), (-1,-2), (3,6), (1,2)\}$, then **(Recall)**

(i) Write domain and range of R.

(ii) Write R in the set-builder form.

Question 5 **[2]**

(i) Find the nominal rate compounded quarterly equivalent to 5% effective rate of interest. **(Understanding)**

OR

(ii) If the present worth of a sum of ₹29,160 due after 2 years is ₹ 25,000, find the rate of interest compounded annually. **(Understanding)**

Question 6 **[2]**

(i) A company launches a marketing campaign for a new product. Online user engagement (in thousands) at time 't' seconds after the campaign stops is modelled by the equation: $I = I_0 \times 2^{-0.02t}$ where:

I is the user engagement at time t,

I_0 is the initial user engagement when the campaign ends.

Calculate the time t (in seconds) at which the engagement drops to 90% from the original level. **(Application)**

OR

(ii) Find the value of x $(x > 0)$ such that $\log_9(\log_3 x) = \log_3(\log_9 x)$. **(Application)**

Question 7 **[2]**

(i) In how many ways can 5 chairpersons be arranged in a row such that

(a) President and Vice-president are always together?

(b) President and Vice-president are never together? **(Application)**

OR

(ii) If the 4th and 9th terms of a Geometric Progression be 54 and 13122 respectively. Find the Geometric Progression. **(Understanding)**

Question 8 **[2]**

Find the derivative of $y = 3sinx - 5cosx + \sqrt{x}$ with respect to x. **(Understanding)**

SECTION C – 21 MARKS

Question 9 **[3]**

Solve for 'x': $\frac{2x^2+x}{x^2-x+1} > 3$ **(Evaluate)**

Question 10 **[3]**

Find all points on the line $x + y = 4$ that lie at a unit distance from the line $4x + 3y = 10$ **(Application)**

Question 11 **[3]**

Let 'f' be a function defined by $f: R \rightarrow R$, such that $f(x) = 5x^2 + 2, x \in R$ **(Understanding)**

(i) Find the image of 3 under f.

(ii) Find the range of the f.

(iii) Find x such that $f(x) = 1{\cdot}5$.

Question 12 **[3]**

For any statement p and q construct the truth tables for: $(\sim p \vee q) \wedge (\sim p \vee \sim q)$.

(Application)

Question 13 **[3]**

(i) The production of an item is given by the function $P(t) = 2t^3 - 15t^2 + 36t$, where $P(t)$ is the number of units produced on the t[th.] day. **(Analysis)**

(a) Find the rate of production at any time t.

(b) Find the rate of production on the 2[nd] day.

(c) Interpret the result of part (b).

OR

(ii) If $y = \frac{e^x tanx}{logx}$, find $\frac{dy}{dx}$ **(Application)**

Question 14 **[3]**

(i) Mr Mohanty lives in Cuttack, Odisha. The reading of electric meter for his house is 6879 units. If the previous month's reading was 5241 units and load is of 5kW, calculate the electric bill for that month. Tariff plan is given below:

Energy charges

Number of units	0 – 50	51 – 200	201 – 400	> 400
Price per unit (₹)	3·00	5·00	6·00	8·00

Fixed charge ₹100 per kW/month

Surcharge is ₹0·25 per unit

Energy tax is 5% of tariff rates. **(Analysis)**

OR

(ii) A man retires at the age of 60 years and his employer gives him a pension of ₹ 22,000 a year paid in half-yearly instalments for the rest of his life. Reckoning his expectation of life to be 15 years and the rate of interest is 8% per annum compounded half yearly, what single sum is equivalent to his pension?

(Analysis)

Question 15 **[3]**

(i) The first four central moments of a frequency distribution are 0, 2·5, 0·7 and 18·75. Answer the following questions. **(Analysis)**

(a) Find moment coefficient of kurtosis.

(b) Do you think it is negatively skewed? Justify your answer.

(c) From the point of view of peaked-ness, which type of curve is it? Justify your answer.

OR

(ii) The following data given below shows the correlation co-efficient, mean and Standard Deviation (s.d) of rainfall and yield of paddy in a certain area of the country:

	Yield per acre	Annual rainfall (cm)
Mean	973·5	18·3
s.d	38·4	2·0

Coefficient of correlation = 0·58

Estimate the most likely yield of paddy when the annual rainfall is 22cm, other factors being assumed to remain constant. **(Evaluate)**

SECTION D – 25 MARKS

Question 16 **[5]**

(i) A company is evaluating two marketing strategies for the next 10 years.

Strategy A

- Investment in the first year is ₹6 lakhs.
- The investment increases by ₹1·5 lakhs each year.
- At the end of 10 years, the company expects a profit of ₹108 lakhs from this strategy.

Strategy B

- Investment in the first year is ₹3 lakhs.
- Each year, the investment becomes 1·5 times the investment of the previous year.
- The company expects to earn ₹272 lakhs profit on the total investment over 10 years. **(Analysis)**

Answer the following questions:

(a) Find the total investment made over 10 years under Strategy A and Strategy B.

(b) Find the total profit percentage for Strategy A and Strategy B.

(c) Which strategy is more cost-effective? Why?

OR

(ii) Your school is preparing for annual function. Chairs are arranged in rows for the guests. Every day, the number of rows and the number of chairs in each row increases to accommodate more people.

On **Day 1**: 1 row with 2 chairs; each chair costs ₹3 → Cost = 1·2·3

On **Day 2**: 2 rows with 3 chairs; each chair costs ₹4 → Cost = 2·3· 4

On **Day 3**: 3 rows with 4 chairs; each chair costs ₹5 → Cost = 3·4·5

and so on...

This pattern continues up to '**n**' days. The total cost of chairs arranged over '**n**' days is: $S_n = 1 \cdot 2 \cdot 3 + 2 \cdot 3 \cdot 4 + 3 \cdot 4 \cdot 5 + \cdots$ upto n terms **(Application)**

(a) Write the cost of chairs arranged on n^{th} day.

(b) Find a rule (formula) to calculate the total cost after '**n**' days.

(c) Find the total cost of chairs for 5 days.

(d) If the total budget is ₹5040, for how many days can chairs be arranged in this pattern?

Question 17 **[5]**

(i) A health team conducted a survey in a community to study the effect of mobile phone usage on eye health. They collected data on the number of people who reported eye problems in different age groups, possibly due to excessive screen time. The collected data are tabulated bellow: **(Analysis)**

Age	20 – 30	30 – 40	40 – 50	50 – 60	60 – 70	70 – 80
No. of persons	9	17	32	23	16	3

(a) Calculate the coefficient of variation (CV) for the age distribution of affected individuals.

(b) Based on the coefficient of variation (CV), evaluate whether the age wise distribution of eye problem is consistent or shows high variability.

(c) Suggest one age targeted awareness strategy that the health team could implement based on your analysis.

OR

(ii) The internal and external assessment on mathematics were conducted for 10 students of class XII. Students obtained the following marks in the assessment.

Roll No of the students:	1	2	3	4	5	6	7	8	9	10
Internal marks (20)	16	18	15	14	12	10	14	9	12	20
External Marks (80)	72	78	64	68	65	45	68	54	60	78

Calculate Spearman's rank correlation coefficient and comment on the result.

(Analysis)

Question 18 **[5]**

(i) If the intercept on the line $y = x$ by the circle $x^2 + y^2 - 2x = 0$ *is* AB, then find the following: **(Application)**

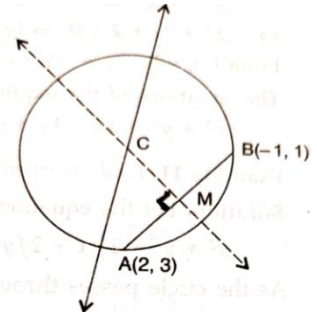
(a) equation of the circle on AB as a diameter. **[3]**

(b) its centre and radius. **[1]**

(c) its equation in parametric form. **[1]**

OR

(ii) Refer to the diagram given below where C is the centre of the circle. **(Analysis)**



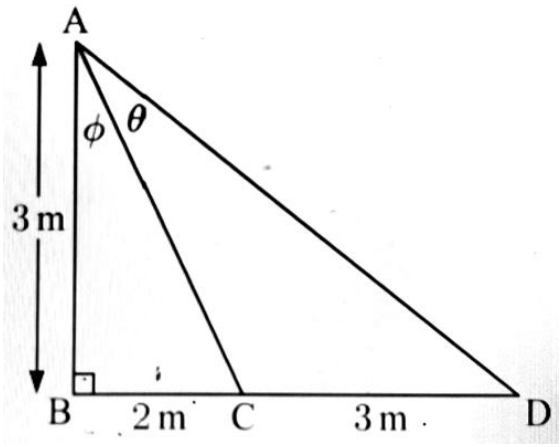
(a) The line through C and perpendicular to the chord AB is a diameter. Justify. Hence, find the equation of this diameter. **[2]**

(b) If the equation of the other diameter is $x - 3y - 11 = 0$, find the coordinates of C. **[1]**

(c) Also, find the equation of the circle. **[2]**

Question 19 **[5]**

Consider the triangle given below: **(Application)**



(i) Write down the ratios $\tan\varphi$ and $\tan(\theta+\varphi)$. **[1]**

(ii) Is there a way to calculate $\tan\theta$ which involves these ratios? If yes, find $\tan\theta$. **[2]**

(iii) Do θ, φ and $\theta+\varphi$ lie in the same quadrant? Justify. Also state the quadrant(s). **[2]**

Question 20 **[5]**

In a financial year 2024-25, the gross salary of Mr. Ajay (aged 45 years) was ₹10,50,000 (excluding HRA) and income from interest on saving account was ₹15,500. He deposited ₹9200 per month in G.P.F. and paid ₹43,000 as life insurance premium.

He donated ₹25,000 in National Security Fund. He took a home loan of ₹ 24,00,000 from state bank of India and paid ₹76000 as interest on home loan and ₹ 20000 as principal of home loan.

Calculate his income tax under old tax regime at the end of the financial year if 4% health and education cess is levied on the payable income tax.

Income tax slab for A.Y 2025-26. **(Application)**

Taxable income	Income Tax
Upto ₹2,50,000 lakh	NIL
₹2,50,001 lakh to ₹ 5 lakh	5% of taxable income exceeding ₹2,50,000
₹5.00,001 lakh to ₹ 10 lakh	₹12,500 + 20% taxable income exceeding ₹5 lakh
Above 10 Lakh	₹1,12,500 + 30% taxable income exceeding ₹10 lakh

APPLIED MATHEMATICS

ANSWER KEY

SECTION A – 20 MARKS

Question 1

In answering Multiple Choice Questions, candidates have to write either the correct option number or the explanation against it. Please note that only ONE correct answer should be written.

(i) (d) Or 25 **[1]**

Let Tennis be represented by T and Cricket by C, sample space by S

students who play neither games is $n(\overline{CUT}) = x$

$n(S) = n(c) + n(T) - n(C \cap T) + n(\overline{CUT})$

$60 = 25 + 20 - 10 + x$

$x = 25$

(ii) (c) Or 2 **[1]**

$\left(\frac{1+i}{1-i} \times \frac{1+i}{1+i}\right)^n = \left(\frac{2i}{2}\right)^n = i^n$; when $n = 2,\ i^2 = -1$, which is real. $n = 2$

(iii) (b) Or Both the statements are false. **[1]**

The given parabola is $3x^2 = -8y$ …..(i)

i.e. $x^2 = -\frac{8}{3}y$

which is comparable with $x^2 = -4y$ so (i) represents a standard (downward) parabola

also $4a = \frac{8}{3} \Rightarrow a = \frac{2}{3}$

Therefore, the equation of directrix is y = a i.e. y = $\frac{2}{3}$

$$3y - 2 = 0$$

∴ Statement I is false

The equation of latus rectum is $y + a = 0$ i.e. $y + \frac{2}{3} = 0$

$$3y + 2 = 0$$

∴ Statement II is false

(iv) (a) Or 120 **[1]**

Number of ways = 5! = 120

(v) (b) Or 0·31 **[1]**

A and B are two mutually exclusive events so $A \cap B = \emptyset$

$P(notA) = 0 \cdot 57,\ so\ P(A) = 0 \cdot 43\ , P\ (A \cup B) = 0 \cdot 74$

$$P(A \cup B) = P(A) + P(B)$$

$$\Rightarrow 0 \cdot 74 = 0 \cdot 43 + q$$

$$\therefore q = 0 \cdot 31$$

(vi) (c) Or present value of annuity. **[1]**

(vii) (a) Or Both Assertion and Reason are true and Reason is the correct explanation for Assertion **[1]**

Explanation: In a negatively skewed distribution (also known as left-skewed), most values are clustered towards the higher end of the scale, and there's a long tail extending towards the negative values (left). This causes the mean to be pulled towards the lower values, resulting in the order: Mean < Median < Mode.

(viii) (b) Both the statements are false. **[1]**

Explanation: Input tax credit of SGST can be utilised for payment of SGST first and balance for payment of IGST on onward supply.

Input tax credit of CGST can be utilised for payment of CGST first and balance for payment of IGST on onward supply.

(ix) (c) Or 252 **[1]**

$$T_6 = T_{1+5} = 10_{C_5}\left(\frac{2x^2}{3}\right)^5\left(\frac{3}{2x^2}\right)^5 = 252$$

(x) (b) Or $y = ax^2 + bx + c, a > 0 \; and \; D < 0$ **[1]**

Curve is facing upwards so a > 0 and curve is neither touching nor intersecting the x – axis hence D < 0

(xi) (b) Or 406 **[1]**

$$\lim_{x\to 3}\frac{x^5 - 3^5}{x - 3} + \lim_{x\to 0} e^x = 5(3^4) + 1 = 405 + 1 = 406$$

(xii) (b) Or $\sqrt{3}$ **[1]**

$$\frac{1}{3} + \frac{1}{3^2} + \frac{1}{3^3} + \cdots . \infty = \frac{\frac{1}{3}}{1 - \frac{1}{3}} = \frac{1}{2}$$

$$3^{\frac{1}{3}+\frac{1}{3^2}+\frac{1}{3^3}+\cdots.\infty} = 3^{\frac{1}{2}}$$

(xiii) (d) Or $x^2y^3 = 3z$ **[1]**

$$\log\left(\frac{x^2y^3}{z}\right) = log3 \Longrightarrow x^2y^3 = 3z$$

(xiv) (a) Or b **[1]**

a, A_1, b, A_2, c

(xv) (c) Or $\frac{3-2i}{13}$ **[1]**

$$\frac{1}{3+2i} \times \frac{3-2i}{3-2i} = \frac{3-2i}{13}$$

(xvi) (a) Or Both Assertion and Reason are true and Reason is the correct explanation for Assertion. **[1]**

${}^{n}C_r = {}^{n}C_{n-r}$ is true. $\therefore {}^{n}C_{12} = {}^{n}C_8 \Rightarrow r = 12 \; and \; n = 12 + 8 = 20$

(xvii) (b) Or $x^2 - 6x + 7 = 0$ **[1]**

One root = $3 + \sqrt{2} \Longrightarrow 3 - \sqrt{2} \; is \; the \; other \; root$

The quadratic equation is,

$x^2 - \left[\left(3+\sqrt{2}\right) + \left(3-\sqrt{2}\right)\right]x + \left(3+\sqrt{2}\right)\left(3-\sqrt{2}\right) = 0$

$\Longrightarrow x^2 - 6x + 7 = 0$

(xviii) TAPE = 4825, SMART = 91834, BONE = 7605 **[1]**

From the above we get the code for B = 7, A = 8, S = 9, E =5, R = 3

So, code language for BASERA is **789538**

(xix) The pendulum describes a circle of radius 75cm and its tip describes an arc of length 21 cm. Let θ radians be the angle through which the pendulum swings. **[1]**

Here r = 75cm and l = 21 cm

$\therefore \theta = \frac{l}{r} = \frac{21}{75} = \frac{7}{25}$

(xx) Let the angle between the given lines be θ **[1]**

slope of $x + y = 0$ be $m_1 = -1$

slope of $y = 0$ be $m_2 = 0$

$tan\theta = \left|\frac{m_1 - m_2}{1 + m_1 m_2}\right| = \left|\frac{-1}{1}\right| = 1$

$\theta = 45° = \frac{\pi}{4}$

SECTION B – 14 MARKS

Question 2 **[2]**

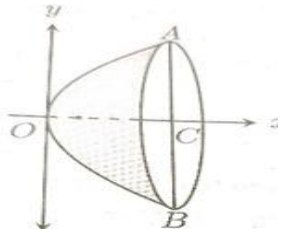
4 persons out of 13 can be selected in ${}^{13}C_4$ ways,

As per the data two gents and two ladies can be selected out of 6 gents and 7 ladies in ${}^{6}C_2 \times {}^{7}C_2$ ways

Required probability: $\frac{{}^{6}C_2 \times {}^{7}C_2}{{}^{13}C_4} = \frac{63}{143}$

Question 3 **[2]**

Let AOB the parabolic reflector which is 20cm in diameter and 5cm deep, then AB = 20cm and OC =5cm



Where C is the midpoint of AB

The equation of the parabola can be taken as

$$y^2 = 4(ax)$$

Since the point A (5, 10) lies on the parabola

$10^2 = 4\,a \times 5 \Rightarrow a = 5$

∴ The coordinate of the focus is (a,0) i.e (5,0)

Question 4 **[2]**

(i) Domain of R = {0,2,−1,3,1}, Range of R = {0,4,−2, 6, 2}

(ii) R in the builder form can be written as

$$R = \{(x, y): x \in I, -1 \leq x \leq 3, y = 2x\}$$

Question 5 **[2]**

(i) Let the nominal rate be r %.

Number of conversions in a year, p = 4

Effective rate of interest = 5% = 0·05 per rupee.

As effective rate per rupee= $\left(1 + \frac{r}{100p}\right)^4 - 1, we\ get$

$0{\cdot}05 = \left(1 + \frac{r}{400}\right)^4 - 1$

$1 \cdot 05 = \left(1 + \frac{r}{400}\right)^4$

$1 + \frac{r}{400} = (1 \cdot 05)^{1/4}$

$\frac{r}{400} = 1 \cdot 01227 - 1$

$r = 4 \cdot 908$

Hence, the nominal rate compounded quarterly is 4·908.

OR

(ii) Here, P.V $= ₹25{,}000, A = ₹29{,}160, n = 2yrs,\ i\ =$?

Now, $P, V = \frac{A}{(1+i)^n} \Rightarrow 25{,}000 = \frac{29160}{(1+i)^2}$

$\therefore\ (1+i)^2 = \frac{2916}{2500}$

$\therefore\ 1+i = 1 \cdot 08$

$\therefore\ i = 8\%$

∴ The rate of interest is 8% p.a.

Question 6 **[2]**

(i) Given, $I = I_0 \times 2^{-0 \cdot 02t}$

We are to find the time when the user engagement becomes 90% of the original.

So, $I = 0 \cdot 9 I_0$

$\Rightarrow I_0 \times 2^{-0 \cdot 02t} = 0 \cdot 9 I_0 \Rightarrow \log 0 \cdot 9 = -0 \cdot 02t\ log 2$

$$\Rightarrow t = \frac{log 0 \cdot 9}{-0 \cdot 02\ log 2} = \frac{-0 \cdot 04576}{-0 \cdot 02 log 2} = \frac{-0 \cdot 04576}{-0 \cdot 02 \times 0 \cdot 3010} = 7.60\ sec$$

OR

(ii) $\log_9(\log_3 x) = \log_3(\log_9 x) \Rightarrow \frac{1}{2}\log_3(\log_3 x) = \log_3\left(\frac{1}{2}\log_3 x\right)$

$\Rightarrow \log_3(\log_3 x) = 2\ \log_3\left(\frac{1}{2}\log_3 x\right) \Rightarrow \log_3(\log_3 x) = \log_3\left(\frac{1}{2}\log_3 x\right)^2$

$\Rightarrow \log_3 x = \frac{1}{4}(\log_3 x)^2 \Rightarrow 4 = \log_3 x \Rightarrow x = 3^4 \Rightarrow x = 81$

Question 7 **[2]**

(i) (a) Number of arrangements where P and V always together = 4!2! = 48 ways

(b) Number ways where P and V never be together =

Total number of arrangements − always be together = 5! – 48 = 72 ways

OR

(ii) $ar^3 = 54,\ ar^8 = 13122 \Rightarrow r^5 = 243 \Rightarrow r = 3\ and\ a = 2$

The GP is, 2, 6, 18, 54, …

Question 8 **[2]**

$\frac{dy}{dx} = 3cosx + 5sinx + \frac{1}{2\sqrt{x}}$

SECTION C – 21 MARKS

Question 9 **[3]**

$\frac{2x^2+x}{x^2-x+1} > 3 \Rightarrow \frac{2x^2+x}{x^2-x+1} - 3 > 0$

$\Rightarrow \frac{x^2-4x+3}{x^2-x+1} < 0$

$\Rightarrow x^2 - 4x + 3 < 0 \left(\because x^2 - x + 1 = \left(x - \frac{1}{2}\right)^2 + \frac{3}{4} > 0, \forall x \in R \right)$

$\Rightarrow (x-1)(x-3) < 0$

$\Rightarrow \boldsymbol{x} \in (1,3)$

Question 10 **[3]**

To take any point on the line $x + y = 4$

Let $x = \alpha$, then from equation of line $y = 4 - \alpha$

Therefore, P $(\alpha, 4-\alpha)$ is any point on the line

It will be required point if its perpendicular distance from the line

$4x + 3y - 10 = 0$ is 1 unit

⇨ $\frac{|4\alpha+3\times(4-\alpha)-10|}{\sqrt{4^2+3^2}} = 1 \Rightarrow |\alpha + 2| = 5$

⇨ $\alpha + 2 = \pm 5$

⇨ $\alpha = 3, -7$

Hence, the required points are (3,1) and $(-7,11)$

Question 11 **[3]**

(i) Given $f(x) = 5x^2 + 2, x \in R$

$f(3) = 5 \times 3^2 + 2 = 5 \times 9 + 2 = 47$

(ii) $f(x) = 5x^2 + 2$

as $x^2 \geq 0$ *for all value of* $x \in R$,

so $5x^2 \geq 0$ hence $5x^2 + 2 \geq 2$, Thus the minimum value of the $f(x)$ is 2 when $x = 0$ and since the function increases without bound as $|x| \to \infty$, the range is $[2,\infty)$

(iii) $f(x) = 1 \cdot 5$ does not belong to the range $[2,\infty)$. Therefore, no real solution exists.

Question 12 **[3]**

p	q	$\sim p$	$\sim q$	$\sim p \vee q$	$\sim p \vee \sim q$	$(\sim p \vee q) \wedge (\sim p \vee \sim q)$
T	T	F	F	T	F	F
T	F	F	T	F	T	F
F	T	T	F	T	T	T
F	F	T	T	T	T	T

Question 13 **[3]**

(i) (a) $\frac{dP}{dt} = 6(t^2 - 5t + 6)$

(b) $\left(\frac{dP}{dt}\right)_{t=2} = 6(2^2 - 5 \times 2 + 6) = 0$

(c) There is no change in the production on the second day.

OR

(ii) $$\frac{dy}{dx} = \frac{logx(e^x sec^2x + tanxe^x) - \frac{1}{x}e^x tanx}{(\log x)^2}$$

$$= \frac{e^x}{(\log x)^2}\left(logx\ sec^2x + logx\ tanx - \frac{tanx}{x}\right)$$

Question 14 **[3]**

(i) Given current month's reading = 6879

Previous month's reading = 5241

Number of unit consumed = 6878 – 5241 = 1578

Energy charges

Units	Price	Amount
0 – 50	₹3.00	₹75
51 – 200	₹5.00	₹750
201 – 400	₹6.00	₹1200
>400	₹8.00	₹9424
	Total	₹11,449

Fixed charges = ₹(110 × 5) = ₹ 550

Surcharge = ₹(0·25 × 1578) = ₹394·50

Energy tax = 5% of ₹11999 = ₹599·95

Total amount of electricity bill = ₹11,449 + ₹550 + ₹394·50 + 599·95

=₹12, 993·45

Hence, electric bill for Mr Mohanty for the month is ₹12, 993·45.

OR

(ii) Half yearly instalment = ₹ 11,000

Rate of interest = 4% half-yearly.

This single sum is evidently the present value of immediate annuity of ₹ 11·000 for 15 years at 4% per half-yearly

A = ₹ 11,000 i =0.04, n= 30 V =?

$V = \frac{A}{i}(1 - (1+i)^{-n})$

$V = \frac{11,000}{0.04}(1 - (1 \cdot 04)^{-30})$

$= 2,75,000\,(1 - 0 \cdot 3083)$

$= 2,75,000 \times 0 \cdot 6817$

$= ₹1,90,217 \cdot 50$

Hence, the single sum equivalent to his pension is ₹ 1,90,217·50

Question 15 **[3]**

(i) (a) We have $\mu_1 = 0, \mu_2 = 2 \cdot 5, \mu_3 = 0 \cdot 7\ and\ \mu_4 = 18 \cdot 75$

Moment coefficient of kurtosis $\beta_1 = \frac{{\mu_3}^2}{{\mu_2}^3} = \frac{(0 \cdot 7)^2}{(2 \cdot 5)^3} = \frac{0 \cdot 49}{15 \cdot 625} = 0 \cdot 031$

(b) Since, $\mu_3 > 0$, so, it is not negatively skewed. The distribution is positively skewed.

(c) $\beta_2 = \frac{\mu_4}{{\mu_2}^2} = \frac{18 \cdot 75}{(2 \cdot 5)^2} = 3$

∴ The value of $\beta_2 = 3$

Hence, the curve is mesokurtic.

OR

(ii) Let yield of paddy per acre be x and annual rainfall be y.

$\overline{x} = 973 \cdot 5,\ \ \overline{y} = 18 \cdot 3$

$\sigma_x = 38 \cdot 4,\ \ \sigma_y = 2 \cdot 0 \ \ and \ \ r = 0 \cdot 58$

$b_{xy} = r\frac{\sigma_x}{\sigma_y}$

$= 0 \cdot 58 \times \frac{38 \cdot 4}{2} = 11 \cdot 136$

Using, $x - \overline{x} = \ b_{xy}(y - \overline{y})$

$\Rightarrow x - 973 \cdot 5 = 11 \cdot 136(y - 18 \cdot 3)$

$\Rightarrow x - 973 \cdot 5 = 11 \cdot 136(22 - 18 \cdot 3)$

$\Rightarrow x = 41 \cdot 2032 + 973 \cdot 5 = 1014 \cdot 70.$

Hence, when the annual rainfall is 22 cm, the most likely yield of paddy is 1014·70 per acre.

SECTION D – 25 MARKS

Question 16 **[5]**

(i) Strategy A follows AP

6, 7.5, 9, 10·5, …

Total Investment $S_{10} = \frac{n}{2}[2a + (n-1)d] = \frac{10}{2}[2(6) + 9(1 \cdot 5)]$

= ₹127·5 lakhs

Strategy B follows GP

3, 4.5, 6·75, 10·125…… having $|r|>1$.

(a) Total Investment $S_{10} = a\left(\frac{r^n - 1}{r-1}\right) = 3\left(\frac{(1.5)^{10} - 1}{1.5-1}\right) = \ ₹340\ lakhs\ (approx)$

(b) Profit for Strategy A = ₹108 lakhs

Profit % for Strategy A = $\frac{108}{127 \cdot 5} \times 100 = 84 \cdot 71\%$

Profit for Strategy B= ₹272 lakhs

Profit % for strategy B = $\frac{272}{340} \times 100 = 80\%$

Profit for Strategy B $= 80\%$

(c) Strategy A. Although Strategy B offers a higher total profit, Strategy A is more cost-efficient due to its higher profit percentage.

OR

(ii) (a) Cost for nth day = $n(n+1)(n+2)$

(b) Total cost after n days = $\sum_{k=1}^{n} k(k+1)(k+2) = \frac{n(n+1)(n+2)(n+3)}{4}$

(c) Total cost for 5 days = $\frac{5.6.7.8}{4} =$ ₹420

(d) $\frac{n(n+1)(n+2)(n+3)}{4} = 5040 \Rightarrow n(n+1)(n+2)(n+3) = 20160$

$n(n+1)(n+2)(n+3) = 2016 \times 10 = 7 \times 8 \times 9 \times 10 \Rightarrow n = 7$

Question 17 **[5]**

(i) (a) Since, the interval are of uniform width 10, we use step deviation method to calculate mean with assumed mean 45

Class interval	Class mark (x_i)	frequency (f)	$t = \frac{x_i - A}{i}$	ft	ft^2
20 – 30	25	9	-2	-18	36
30 – 40	35	17	-1	-17	17
40 – 50	45	32	0	0	0
50 – 60	55	23	1	23	23
60 – 70	65	16	2	32	64
70 – 80	75	3	3	9	27
Total		$\sum f$ =100		$\sum ft$ =29	$\sum ft^2$ =167

Mean = $A + \frac{\sum ft}{\sum f} \times i = 45 + \frac{29}{100} \times 10 = 47 \cdot 9$

Standard deviation $(\sigma) = \sqrt{\frac{\sum ft^2}{\sum f} - \left(\frac{\sum ft}{\sum f}\right)^2} \times i$

$= \sqrt{\frac{167}{100} - \left(\frac{29}{100}\right)^2} \times 10$

$= 10\sqrt{1 \cdot 67 - 0 \cdot 0841}$

$= 10 \times 1 \cdot 2593$

$= 12 \cdot 59$

Hence, mean of the given data is 47·9 and Standard deviation is 12·59

The coefficient of variation (CV) = $\frac{\sigma}{\bar{x}} \times 100 = \frac{12 \cdot 59}{47 \cdot 9} \times 100 = 26 \cdot 28\ \%$

(b) As C.V of 26.29% indicates a moderate variability in the age distribution of people reporting eye problems. This means the eye problem are not highly concentrated in one particular age group, but moderately spread out, with the mean age of affected individuals being around 48 years

(c) Since the mean age is approximately 48 years and variability is moderate, the health team could target awareness program at the 40 – 50 age group. This group eye problem due to professional screen expose or reduce eye resistance. Campaigns could be focus on promoting regular eye checkups and screen time management and eye exercise for working adult.

OR

(ii)

Internal marks (x)	Rank (R_1)	External Marks (y)	Rank (R_2)	Difference d = ($R_1 - R_2$)	d^2
16	3	72	3	0	0
18	2	78	1·5	0·5	0·25
15	4	64	7	-3	9
14	5·5	68	4·5	1	1
12	7·5	65	6	1·5	2·25
10	9	45	10	-1	1
14	5·5	68	4·5	1	1
9	10	54	9	1	1
12	7·5	60	8	$-0\cdot5$	0·25
20	1	78	1·5	$-0\cdot5$	0·25
Total					$\sum d^2 = 16$

Spearman's rank correlation coefficient (r) = $1 - \frac{6\left\{\sum d^2 + \sum \frac{1}{12}(m^3 - m)\right\}}{n^3 - n}$

Here, $r = 1 - \frac{6\left\{16 + \frac{1}{12}(2^3-2) + \frac{1}{12}(2^3-2) + \frac{1}{12}(2^3-2) + \frac{1}{12}(2^3-2)\right\}}{10^3 - 10}$

$$r = 1 - \frac{6\{16 + 0.5 + 0.5 + 0.5 + 0.5\}}{990}$$

$$= 1 - \frac{108}{990}$$

$$= 1 - 0\cdot109$$

$$= 0\cdot891.$$

Hence, rank correlation is 0·891, which shows a high positive relation between the internal marks and external marks.

Question 18 **[5]**

(i) (a) The equation of line is $y = x$ ---------- (i)

and the equation of the circle is

$x^2 + y^2 - 2x = 0$ ---------- (ii)

Solving (i) and (ii) simultaneously for point of intersection we have

$x^2+y^2 - 2x = 0 \Rightarrow 2x(x-1) = 0$

$\Rightarrow x = 0,1$

From (i), when $x = 0, y = 0$ when $x = 1, y = 1$

$\therefore$ The points of intersections are A (0,0) and B (1,1).

The equation of the circle on AB as diameter is

$$(x-0)(x-1) + (y-0)(y-1) = 0$$

i.e. $x^2 + y^2 - x - y = 0$

(b) Standard form

$x^2+y^2 - x - y + \frac{1}{4} + \frac{1}{4} = \frac{1}{4} + \frac{1}{4}$

$$\left(x - \frac{1}{2}\right)^2 + \left(y - \frac{1}{2}\right)^2 = \frac{1}{2}$$

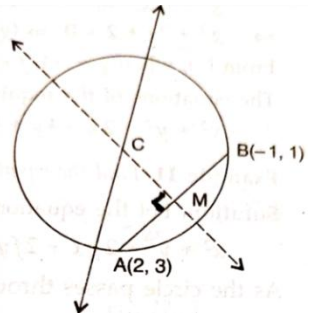
radius = $\frac{1}{\sqrt{2}}$, centre = $(\frac{1}{2}, \frac{1}{2})$

(c) Parametric equation of circle: $x = \frac{1}{2} + \frac{1}{\sqrt{2}}\cos t$, $y = \frac{1}{2} + \frac{1}{\sqrt{2}}\sin t$, where $0 < t \leq 2\pi$

OR

(ii) (a) In a circle, the perpendicular from the centre to a chord bisects the chord. If a line through the centre C is perpendicular to a chord AB it must pass through the midpoint of the chord. Since it starts from the centre and goes straight across the circle, it's a diameter.

Therefore, CM is a diameter.



The midpoint M of the chord AB = $\left(\frac{1}{2}, 2\right)$

Slope of AB = $\frac{-2}{-3} = \frac{2}{3}$

Slope of CM= $\frac{-1}{slope\ of\ AB} = \frac{-3}{2}$

Equation of CM will be: $y - 2 = \frac{-3}{2}(x - \frac{1}{2})$

$y = \frac{-3}{2}x + \frac{3}{4} + 2$

$6x + 4y = 11$

(b) If the equation of the other diameter is $x - 3y - 11 = 0$

The intersection point of the two diameters will give centre C(x, y), hence solving the two equations of two diameters

$6(3y + 11) + 4y = 11$

$x = \frac{7}{2}$ and $y = -\frac{5}{2}$ so centre $C\left(\frac{7}{2}, -\frac{5}{2}\right)$

(c) With Centre $C\left(\frac{7}{2}, -\frac{5}{2}\right)$ and using $A\ (2, 3)$ we find radius of the circle.

Radius of the circle $r = \sqrt{\left(2 - \frac{7}{2}\right)^2 + \left(3 + \frac{5}{2}\right)^2} = \sqrt{\frac{65}{2}}$

Equation of the given circle will be

$$\left(x - \frac{7}{2}\right)^2 + \left(y + \frac{5}{2}\right)^2 = \frac{65}{2}$$

Question 19 **[5]**

Given two right angle triangles i.e. △ABC and △ABD,

(since BD=BC + CD = 2+3 = 5m)

(i) In triangle ABC : $\tan \emptyset = \frac{BC}{AB} = \frac{2}{3}$

In triangle ABD : $\tan(\theta + \emptyset) = \frac{BD}{AB} = \frac{5}{3}$

(ii) Yes, i.e. $\tan(\theta + \emptyset) = \frac{\tan\theta + \tan\emptyset}{1 - \tan\theta.\tan\emptyset}$

Let $\tan\theta = x$, then

$$\frac{5}{3} = \frac{x + \frac{2}{3}}{1 - x.\frac{2}{3}}$$

$\frac{5}{3}(1 - \frac{2x}{3}) = x + \frac{2}{3}$

$\Rightarrow x = \frac{9}{19}$ therefore $\tan\theta = \frac{9}{19}$

(iii) Yes, $\theta, \emptyset$ and $\theta + \emptyset$ lies in the same quadrant.

$\tan\emptyset$,$\tan(\theta + \emptyset)$ and $\tan\theta$, all are positive,

$\Rightarrow$ All angles will lie either in 1st or in 3rd. quadrant.

From the figure,$\emptyset$ is angle of right triangle ABC, hence it is an acute angle.

Also, $\theta + \emptyset$ is an angle of right triangle ABD, hence it is also an acute angle.

$\Rightarrow \theta$ is also an acute angle.

Hence θ, φ and $\theta + \varphi$ lies in the 1st quadrant.

Question 20 **[5]**

Calculation of Income tax for financial year 2024-25 (Old Tax Regime)

Income from salary	= ₹ 10,50,000
Income from interest on saving account	= + ₹ 15,500
∴ Gross income	= ₹10,65,500
Less standard deduction	= −₹ 50,000
Balance	= ₹10, 15,500

Deduction under section 80G

Donation in National Security Fund	= − ₹25,000
Deduction under section **80 TTA** on interest from saving account	= − ₹10000
Balance	= ₹ 9,80,500

Deduction under section 24

Interest on home loan	= −₹ 76000
Balance	= ₹ 9,04,500

Deduction under section 80C

Deposited in G.P.F ₹ (12 × 9200)	= ₹ 1,10,400
LIC premium	= ₹ 43000
Principal of home loan	= ₹ 20000
Total	= ₹ 1,73,400
But deduction under section 80C is allowed up to ₹1,50,000	
Less deduction under section 80C	= − ₹1,50,000
Taxable income	= ₹ 7, 54, 500

Since, taxable income is ₹ 7, 54, 500, so from income tax slab

Income tax = ₹ 12,500+ 20% of 2,54,500

= ₹ 12,500 + ₹50,900

= ₹ 63,400.

Since taxable income is more than 5 lakh, so Mr Ajay is not eligible for tax rebate under section 87A

∴ Income tax	= ₹ 63,400
Health and education cess 4% on ₹63,400	= + ₹2,536
Net Income tax	= ₹ 65,936.