# Institute of Actuaries of India

## ACET March 2025 Indicative Solution

### Mathematics

| | | |
|---|---|---|
| 1 | C | The minimum occurs when x = 0, and f(0) = ln(45) ≈ 3.8. |
| 2 | D | If x ≥ 0, f(x) = g(x). If x < 0, f(x) > g(x). |
| 3 | B | The equation simplifies and factorizes to $2(x+1)(x^2-x+2)=0$, which has only one real root -1 and two non-real roots coming from the quadratic factor. |
| 4 | C | Note that $\int_0^{2025}[x]\{x\}dx = \sum_{i=0}^{2024}\int_i^{i+1} i(x-i)dx = \sum_{i=0}^{2024} i \int_0^1 xdx = \left(\int_0^1 xdx\right)\sum_{i=0}^{2024} i = [\frac{x^2}{2}]_0^1 * \left(2024 * \frac{2025}{2}\right) = 2025 * 506$. So $\frac{I}{2025} = 506$ which is an even integer not divisible by 4. |
| 5 | A | Note that $-m = a^2 + b^2 = (a+b)^2 - 2ab = 20^2 - 2*25 = 350$. So, m = -350.<br>Likewise, $n = a^2 * b^2 = (ab)^2 = 25^2 = 625$. So, P(1) = 1 + m + n = 276. |
| 6 | D | $\lim_{x\to 0}\frac{\tan\left(\frac{x}{20}\right) - \tan\left(\frac{x}{25}\right)}{\sin\left(\frac{x}{2025}\right)} = \lim_{x\to 0}\frac{\frac{\tan\left(\frac{x}{20}\right)}{x} - \frac{\tan\left(\frac{x}{25}\right)}{x}}{\frac{\sin\left(\frac{x}{2025}\right)}{x}}$<br>$= \lim_{x\to 0}\frac{\frac{\frac{1}{20}\tan\left(\frac{x}{20}\right)}{\frac{x}{20}} - \frac{\frac{1}{25}\tan\left(\frac{x}{25}\right)}{\frac{x}{25}}}{\frac{1}{2025}\frac{\sin\left(\frac{x}{2025}\right)}{\frac{x}{2025}}} = \lim_{x\to 0}\frac{\frac{1}{20} - \frac{1}{25}}{\frac{1}{2025}} = \frac{2025}{100} = 20.25$ |
| 7 | B | Since $a_{25}$ = 20 and r = (20/25)^(1/5) = 0.8^0.2, the next integer in this GP is $a_{30}$ = 20*0.8 = 16. So, k = 30 and $a_k$ = 16. |
| 8 | B | Unit vector in direction of $\vec{a} = \frac{\vec{a}}{\|\vec{a}\|} = \frac{20\hat{\imath}+25\hat{\jmath}}{\sqrt{20^2+25^2}} = (\frac{4}{\sqrt{41}})\hat{\imath} + (\frac{5}{\sqrt{41}})\hat{\jmath}$ |
| 9 | D | While $\vec{a}\cdot\vec{b} = \vec{b}\cdot\vec{a}$, $\vec{a}\times\vec{b} = -\vec{b}\times\vec{a}$. |
| 10 | C | A skew symmetric matrix can have a non-zero determinant, e.g. $\begin{bmatrix}0 & -1\\ 1 & 0\end{bmatrix}$ |
| 11 | D | DCB is 25x25 while $A^T$ is 20x20, so not compatible. |
| 12 | C | Since f(x) = 0 for x≤0 and f(x) = $4x^2$ for x>0, f is defined and continuous everywhere.<br>It is also infinitely differentiable everywhere, except possibly at x=0.<br>At x=0, derivative from left = 0, derivative from right = 8x = 0. So differentiable everywhere.<br>At x = 0, second derivative from left = 0, 2nd derivative from right = 8. So not twice differentiable everywhere. |
| 13 | A | Note that $\frac{dy}{dx} = \frac{x^n e^x - e^x n x^{n-1}}{(x^n)^2} = \frac{e^x x^n(1-\frac{n}{x})}{x^{2n}} = 0$ when x=n. |
| 14 | A | Let r be the common ratio. So, $d = ar^3$, $c = ar^2$ and $b = ar$. Also, $0 = a+b+c+d = a(1+r+r^2+r^3)=a(1+r)(1+r^2)$ which implies a=0 or r=-1. Since a=0 will imply a=b, r must be -1. This will lead to a = -b = c = -d. So, $(c/d)^{2025} = -1$. |


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|---|---|---|
| 15 | C | The expression will have terms such as $(1 + c_1x + c_2x^2 + \cdots + c_{20}x^{20}) + (c_{25}x^{25} + c_{26}x^{26} + \cdots + c_{45}x^{45}$. So, the total terms is 21+21 = 42. |
| 16 | B | We simplify: $\sum_{n=1}^{\infty} \frac{n-1}{n!} = \sum_{n=2}^{\infty} (\frac{n}{n!} - \frac{1}{n!}) = \sum_{n=2}^{\infty} (\frac{1}{(n-1)!} - \frac{1}{n!}) = \frac{1}{1!} = 1.$ |
| 17 | C | Trapezoidal rule: 1/4*(f(0)+2f(0.5)+f(1)) = 20. So, f(0)+f(1) + 2f(0.5) = 80.<br>Simpson's 1/3rd rule: 1/6*(f(0)+4f(0.5)+f(1)) = 25. So, f(0)+f(1) + 4f(0.5) = 150.<br>So, 2f(0.5) = 70 or f(0.5) = 35. |
| 18 | D | Using x=0,1,2, we figure that f(x) is approximated as $2x^2+2x-5$. This means f(6) should have been 79, rather than 77. |
| 19 | A | The product of a complex number and its conjugate equals the square of its modulus, which must be a nonnegative real number. |
| 20 | C | The given expression is a factor of $\alpha^7-1$, so $\alpha^7=1$. Thus, $\alpha^{2025} = \alpha^{7*289}\ \alpha^2 = 1*\ \alpha^2 = \alpha^2$. |

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<table>
<tr><td>21</td><td>B</td><td>Since $0^3+1^3+\ldots9^3 = 2025$, $Pr(N=j) = j^3/2025$ for j in {0,1,…,9}.<br>Mode M = value of j with maximum probability = 9.<br>$Pr(N\geq9) = Pr(N=9) = 729/2025 < 0.5$. $Pr(N\geq8) = Pr(N=8)+Pr(N=9) = (512+729)/2025 > 0.5$. So median m = 8.</td></tr>
<tr><td>22</td><td>D</td><td>Let original number be n and the height of new students be h. So, $(170*n + h*5)/(n+5) = 172$. This simplifies to: $2n + 860 = 5h$. So, n depends on h (which is not given) so there is insufficient information. If h=180, n=20. If h=182, n=25 and so on.</td></tr>
<tr><td>23</td><td>A</td><td>For the first teacher, the four grades can be chosen in ${}^6C_4 = 15$ ways. For each grade, there are 2 choices for section. So total choices = $15*2^4 = 240$.<br>For the second teacher, exactly two of the grades MUST be common with first teacher (possible choices = ${}^4C_2 = 6$, no further choice of section available) and for the other two grades, there are two choices for section. So total choices = $6*2^2 = 24$.<br>For the third teacher, no choices remain. So overall total choices N = 240*24 = 5760.<br>So, largest integer not exceeding N/100 (i.e. 57.6) = 57 is an odd composite number.</td></tr>
<tr><td>24</td><td>C</td><td>The overall median could be anything between 20 and 25, but cannot lie outside this range. The overall proportion of students with less than 20 marks < 0.5. The overall proportion of students with more than 25 marks < 0.5. So median cannot lie outside the range [20,25].</td></tr>
<tr><td>25</td><td>B</td><td>$P(M|S)=P(M\cap S)/P(S)$; $P(S|M)=P(M\cap S)/P(M)$. So $P(M|S)/P(S|M) = P(M)/P(S) = p/q$.<br>Then p/q = 20%/25% = 0.8.</td></tr>
<tr><td>26</td><td>A</td><td>The number of ways of arranging 7 objects is 7! = 5040. However, there are two identical objects (As), so we divide by 2 to get 2520 distinct ways.</td></tr>
<tr><td>27</td><td>C</td><td>For a fair die, $Q_1 = 2$ and $Q_3 = 5$. So IQR = 5 – 2 = 3. Range = 6 – 1 = 5. Ratio = 3/5 = 0.6.</td></tr>
<tr><td>28</td><td>A</td><td>By memorylessness property of exponential distribution, $Pr(X>4|X>2) = Pr(X>2)$, which equals $e^{-2/2} = 1/e = 0.368$.</td></tr>
<tr><td>29</td><td>D</td><td>$Var(aX+b) = a^2*Var(X) = a^2\sigma^2$.</td></tr>
<tr><td>30</td><td>C</td><td>Binomial distribution is symmetric iff p = ½.</td></tr>
<tr><td>31</td><td>B</td><td>We compute probability mass functions as:
<table>
<tr><td>x</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>P(x)</td><td>1/36</td><td>3/36</td><td>5/36</td><td>7/36</td><td>9/36</td><td>11/36</td></tr>
</table>
E(X) = (1*1+2*3+3*5+…+6*11)/36 = 161/36. Median = 5.<br>So difference = 5 – 161/36 = 19/36 which lies in (0.5,1).</td></tr>
<tr><td>32</td><td>A</td><td>Modal score = one with highest frequency = 67 (occurs thrice), is unique.</td></tr>
<tr><td>33</td><td>D</td><td>Regression line 1: y = (-3/2)x + 13. So regression coefficient 1 = -3/2.<br>Regression line 2: x = (-1/6)y +31/6. So regression coefficient 2 = -1/6.<br>So, size of correlation coefficient = sqrt(regression coefficient 1 * regression coefficient 2) = sqrt(-1/6*-3/2) = ½. Since regression coefficients are negative, so is the correlation coefficient. So, correlation coefficient = -0.5.</td></tr>
<tr><td>34</td><td>A</td><td>$E(X) = (1+2+\ldots+6)/6 = 7/2$. Likewise, $E(X^2) = (1^2+2^2+\ldots+6^2)/6 = 91/6$. Similarly, $E(X^3) = (1^3+2^3+\ldots+6^3)/6 = 147/2$. So, $Cov(X,X^2) = E(X*X^2)-E(X)E(X^2) = 147/2 – 637/12 = 245/12$.</td></tr>
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<table>
<tr><td>35</td><td>D</td><td>The PDF is 0 outside of (20,25). In that interval, the PDF makes an isosceles triangle with the x-axis with base = 5 and height = 2.5k. Since the integral / area under the PDF curve over the range must be 1, we get area of triangle = ½*5*2.5k = 1. So k = 0.16.</td></tr>
<tr><td>36</td><td>B</td><td>Let’s tabulate the various cases of n as follows:
<table>
<tr><td>N</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>0</td></tr>
<tr><td>Pr(n heads)</td><td>5/32</td><td>5/16</td><td>5/16</td><td>5/32</td><td>1/32</td><td>1/32</td></tr>
<tr><td>Expected sum of die rolls</td><td>3.5</td><td>14</td><td>31.5</td><td>56</td><td>87.5</td><td>0</td></tr>
</table>
Expected sum of die rolls = 5/32*3.5 + … + 1/32*87.5 = 26.25.</td></tr>
<tr><td>37</td><td>C</td><td>Mean(Y) = s/2; Var(Y) = $s^2/12$. Equating the two and solving for positive s gives s=6.</td></tr>
<tr><td>38</td><td>A</td><td>If A and B are independent, so are A and $B^c$, $A^c$ and $B^c$. For example, X can be proved as: $P(A \cap B^c)=P(A) – P(A \cap B) = P(A)-P(A)P(B) = P(A)(1-P(B)) = P(A)P(B^c)$.</td></tr>
<tr><td>39</td><td>C</td><td>Equating the PMF for Poisson distribution at x=a and x=a+1 and simplifying, we get: m = a+1.</td></tr>
<tr><td>40</td><td>B</td><td>There must be one end point on line m, which can be chosen in 20 ways. The other end point must be on line n and can be chosen in 25 ways. So, total ways = 20*25 = 500.</td></tr>
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<table>
<tr><td>41</td><td>B</td><td>Since the time period is uniform for all outlets, highest CAGR is equivalent to highest growth (2025 sales divided by 2021 sales). This is highest for V (221%).</td></tr>
<tr><td>42</td><td>A</td><td>
<table>
<tr><td>Year</td><td>2021</td><td>2022</td><td>2023</td><td>2024</td><td>2025</td></tr>
<tr><td>Median sales</td><td>180.5</td><td>233.5</td><td>201</td><td>237</td><td>275</td></tr>
</table>
The steepest growth is from 2021 to 2022, to the tune of 233.5/180.5 - 1 = 29.4%.
</td></tr>
<tr><td>43</td><td>A</td><td>The outlet with the highest sales during observation period is Y (sales = 1371).<br>Y had its lowest sales (of 178) in 2021.</td></tr>
<tr><td>44</td><td>D</td><td>X’s market share in 2022 was 7%, which was the lowest.</td></tr>
<tr><td>45</td><td>C</td><td>Deliveries: Peak = ~100, Off-peak = ~50, Ratio = 2:1 (approx.)</td></tr>
<tr><td>46</td><td>B</td><td>Success-rate: Peak = ~60%, Off-peak = ~90%, Ratio = 2:3 (approx.)</td></tr>
<tr><td>47</td><td>C</td><td>Late deliveries: Peak = ~40%, Off-peak = ~10%, Overall = (40%*2+10%*1)/3 = 30% (approx.)</td></tr>
<tr><td>48<br>49<br>50<br>51</td><td>A<br>C<br>B<br>D</td><td>The given information can be analysed to produce the following table:
<table>
<tr><td></td><td>Alpha</td><td>Beta</td><td>Gamma</td><td>Delta</td></tr>
<tr><td>Sales</td><td>50</td><td>100</td><td>30</td><td>120</td></tr>
<tr><td>Expenses</td><td>30</td><td>90</td><td>24</td><td>116</td></tr>
<tr><td>Profit</td><td>20</td><td>10</td><td>6</td><td>4</td></tr>
<tr><td>Margin</td><td>40%</td><td>10%</td><td>20%</td><td>3.33%</td></tr>
</table>
From these, the answers follow:<br>48. 50+100+30+120 = 300<br>49. 116 – 90 = 26<br>50. Median of {20,10,6,4} = (10+6)/2 = 8<br>51. Ratio of max to min = 40%/3.33% = 12</td></tr>
</table>


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| | | |
|---|---|---|
| 52 | D | |
| 53 | C | 'A' one-eyed person |
| 54 | B | |
| 55 | A | |
| 56 | B | It should be "whether" instead of "weather". |
| 57 | A | |
| 58 | D | 'Canter' means 'run'; others mean 'shout'. |
| 59 | C | |
| 60 | C | "*As the world improves, our threshold for complaining drops.*" But that does not mean that humans always complain about increasingly petty problems over time. In fact, if an existential crisis were to emerge (of which the 9/11 terrorism incident was an example), people get serious and stop complaining about petty problems. |
| 61 | B | |
| 62 | C | Please give me a blank **sheet of** paper.<br>Please tell me how **I can** improve my English. |

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<table>
<tr><td>63</td><td>C</td><td>Republic Day (RD) and Independence Day (ID) are on Sunday and Friday in 2025. So their days in a non-leap year will never be same / consecutive – so they cannot both fall on a weekend in a non-leap year. It remains to check leap years. From a leap year to next, they will move by 5 days.
<table>
<tr><td>Year</td><td>2028</td><td>2032</td><td>2036</td><td>2040</td><td>2044</td><td>2048</td></tr>
<tr><td>26-Jan</td><td>Wed</td><td>Mon</td><td>Sat</td><td>Thu</td><td>Tue</td><td>Sun</td></tr>
<tr><td>15-Aug</td><td>Tue</td><td>Sun</td><td>Fri</td><td>Wed</td><td>Mon</td><td>Sat</td></tr>
</table></td></tr>
<tr><td>64</td><td>A</td><td>This happens at integer number of hours, which are 24 in a 24-hour period.</td></tr>
<tr><td>65</td><td>B</td><td>Number of unit cubes with exactly three sides pink will be 8, independent of n.</td></tr>
<tr><td>66</td><td>D</td><td>One’s father = sun’s son, one’s mother = moon’s sister</td></tr>
<tr><td>67</td><td>A</td><td>The ordering should be man – woman – man – woman – man.<br>Since the man in the middle has both women adjacent, only Mr. Z can be there.<br>The remaining positions / individuals are not uniquely determined as there are two possibilities: (Mr. X, Mrs. Y, Mr. Z, Mrs. X, Mr. Y) OR (Mr. Y, Mrs. X, Mr. Z, Mrs. Y, Mr. X).</td></tr>
<tr><td>68</td><td>D</td><td>Y follows as runners are subset of athletes which is disjoint from mathematicians.<br>X need not be true as some (non-athlete) scientist can be a mathematician.</td></tr>
<tr><td>69</td><td>C</td><td>Symptom is seen, followed by diagnosis, leading to treatment being prescribed and eventually disease being cured.</td></tr>
<tr><td>70</td><td>B</td><td>n-th term is sum of factorials of first n positive integers. $5^{th}$ term should have been 33+120 = 153 (not 163).</td></tr>
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