

Department of Chemical Engineering, IIT Bombay

5 February, 2025

Name:

Application Number:

Marks obtained (for office use):

Instructions:

- Time allowed: 1.5 hours.
- Calculators/mobile phones not allowed.
- All questions are multiple choice questions: multiple options are provided of which only one is correct. Clearly circle your choice of the correct answer if any. It is not essential to attempt all questions.
- Correct Answer: +2 marks; Incorrect Answer: -1 mark; No attempt: 0 mark
- Maximum Marks: 60

I declare that I have read all instructions and will abide by them.

Name:

Signature with date:

1. Consider a coin with probability of obtaining a head on a single toss being 0.6 and probability of obtaining a tail being 0.4. If this coin is tossed two times, the probability of obtaining heads in both the tosses is:
 - (a) 0.6
 - (b) 0.36
 - (c) 0.4
 - (d) 0.16
 - (e) 0.24

2. To attract customers, a shop has come up with a novel discount scheme. Every time you shop at it, it gives you a discount which is half of the discount it gave you the last time. If it gives you a discount of 50 Rs. the first time you shop at it, what is the total discount you will get from the shop over your life time. You can assume that since you like this scheme very much, you will buy things from the shop for your entire life (essentially infinite number of times).
 - (a) 100
 - (b) 50
 - (c) 75
 - (d) 200
 - (e) ∞

3. The minimum of the function: $2x^2 - 10x + 12$ occurs at
 - (a) 2
 - (b) 3
 - (c) 0
 - (d) 2.5
 - (e) $-\infty$
 - (f) ∞

4. In the group stage (India topped its group) of a cricket world cup, Virat Kohli's scores in 5 of the 6 games that India played were: 107 (versus Pakistan), 46 (versus South Africa), 33 (versus UAE), 33 (versus West Indies) and 44 (versus Ireland). However, his score against Zimbabwe has not been provided. If it is known that his average score in the group stage was 50, then what was his score against Zimbabwe? [You can assume that he was dismissed in all the matches. Thus, his average is the sum of the scores in all the group matches divided by number of group matches].
 - (a) can't calculate
 - (b) 40
 - (c) 37
 - (d) 41
 - (e) 33

5. Consider that your smart phone has a memory of 100 Megabytes (assume you have a smart phone even if you don't). Storing one phone number in your phone memory consumes 1 byte. Given that 1 Megabyte = 1024 kilobytes and 1 kilobyte = 1024 bytes, upto how many phone numbers can you store in your phone's memory?
 - (a) $100 \times (1024)^2$
 - (b) 100

- (c) 1024
- (d) $(1024)^2$

6. Consider the following system of equations in unknowns x_1, x_2, x_3 :

$$\begin{aligned}x_1 + 2x_2 + 3x_3 &= 6 \\2x_1 + 4x_2 + 6x_3 &= 10 \\x_1 + 2x_2 - 3x_3 &= 0\end{aligned}$$

The system has

- (a) No solution
 - (b) Unique (exactly one) solution
 - (c) Infinite number of solutions
 - (d) Two solutions
 - (e) Can't say
7. It is given that y is a quadratic function of x i.e. $y = a + bx + cx^2$. It is further given that at $x = 0$, the value of y is 1, of its first derivative is 2 while its second and higher derivatives are 0. What are the values of a, b, c ?
- (a) $a = 0, b = 2, c = 1$
 - (b) $a = 1, b = 0, c = 2$
 - (c) $a = 1, b = 2, c = 0$
 - (d) Inadequate information to calculate them
8. Consider four unknown numbers a, b, c, d . It is given that $a > b, b > c$ and $c < d$. Then what can we say about the relation between a and d :
- (a) $a > d$
 - (b) $a < d$
 - (c) $a = d$
 - (d) $a \neq d$
 - (e) Can't say anything
9. Consider that only 15 candidates have turned up for the interview and the chemical engineering department has created 15 panels to interview those 15 candidates. Now if every panel has to interview exactly one candidate each and if every candidate has to be interviewed exactly once, then in many different ways can the candidates be allotted to the panels?
- (a) 15^2
 - (b) 2^{15}
 - (c) $15!$
 - (d) 2×15
10. In a class of 50 students, the average final exam score of first (roll number wise) 49 students is known to be 60. If the 50th student has a score of 10, then the average score of the entire class (50 students) is:
- (a) 59
 - (b) 60
 - (c) 10
 - (d) 35

(e) Cannot be computed

11. The density of water at room conditions is:

- (a) 1000 kg/m³
- (b) 1000 kg/litre
- (c) 100 kg/m³
- (d) 100 kg/litre

12. You are driving from Mumbai to Pune (a distance of 190 km) on a day when there is lot of traffic on the road. For the first 90 kms, your driving speed is 30 km/hr while for the last 100 kms, your driving speed is 50 km/hr. The total time taken by you to reach Pune is:

- (a) 5 hrs
- (b) 4.75 hrs
- (c) 4.5 hrs
- (d) 3.8 hrs
- (e) 6.33 hrs

13. $\int_0^3 x^2 dx =$

- (a) 0
- (b) 81
- (c) 729
- (d) 9
- (e) 3

14. Consider a matrix $X = \begin{bmatrix} 2 & 1 \\ 0 & 2 \end{bmatrix}$. Its inverse matrix is:

- (a) $\begin{bmatrix} 1/2 & -1/4 \\ 0 & 1/2 \end{bmatrix}$
- (b) $\begin{bmatrix} 2 & 0 \\ 1 & 2 \end{bmatrix}$
- (c) $\begin{bmatrix} 1/2 & 0 \\ -1/4 & 1/2 \end{bmatrix}$
- (d) $\begin{bmatrix} 1/2 & 0 \\ 0 & 1/2 \end{bmatrix}$

15. Leibniz rule for differentiating an integral is:

$$\frac{\partial}{\partial x} \left[\int_{a(x)}^{b(x)} f(t, x) dt \right] = \int_{a(x)}^{b(x)} \frac{\partial f(t, x)}{\partial x} dt + \frac{db(x)}{dx} \times f(b(x), x) - \frac{da(x)}{dx} \times f(a(x), x)$$

Using the above rule, the expression for

$$\frac{\partial}{\partial x} \left[\int_0^{3x} (2xt) dt \right]$$

is:

- (a) $27x^2$
- (b) $9x^2$
- (c) 0

- (d) $18x^2$
(e) Can't be computed
16. Starting from a point, say O, you take the following sequence of 4 steps: 1 step East, 1 step North, 1 step East and 1 step North. If each step is of length 1 meter, how far away you are from O?
- (a) $\sqrt{2}$ meters
(b) 2 meters
(c) 0 meters
(d) $2\sqrt{2}$ meters
17. Consider a motorcycle moving in a straight line. If the radius of its back wheel is 0.5 meters, estimate the distance traveled by the motorcycle given that the wheel has turned 20 times.
- (a) 20π meters
(b) 10π meters
(c) 0.5π meters
(d) 40π meters
18. Two of the three roots of a cubic polynomial in x are: $2, i$ where $i = \sqrt{-1}$. Then the cubic polynomial in question is:
- (a) $x^3 - 2x^2 + x - 2$
(b) $x^3 + x^2 - (2 + i)x + 2i$
(c) $x^3 + x^2 + 1$
(d) Can't determine due to inadequate information
19. The variance of a set of numbers: 2,3,4,3 is:
- (a) $2/4$
(b) 3
(c) $2/3$
(d) 2
(e) 4
20. What is the approximate value of the acceleration due to gravity:
- (a) 980 m/s^2
(b) 98 m/s^2
(c) 9.8 m/s^2
(d) 0.98 m/s^2
(e) 0.098 m/s^2
21. If the growth rate of a microorganism is $\frac{d \ln N}{dt} = a$, where N is the number of organisms, its doubling time is
- (a) $\ln 2$
(b) $a \ln 2$
(c) $\ln 2/a$
(d) $1/a$
(e) $2a$

22. The product of multiplication of two matrices $\begin{bmatrix} 8 & 4 \\ -3/2 & 3 \end{bmatrix}$ and $\begin{bmatrix} 2 & 4 \\ -1 & 3 \end{bmatrix}$ is

(a) $\begin{bmatrix} 10 & 8 \\ -5/2 & 6 \end{bmatrix}$

(b) $\begin{bmatrix} 12 & 44 \\ -6 & 3 \end{bmatrix}$

(c) $\begin{bmatrix} 16 & 16 \\ 3/2 & 9 \end{bmatrix}$

(d) $\begin{bmatrix} 10 & 8 \\ -5/2 & 8 \end{bmatrix}$

(e) $\begin{bmatrix} 14 & 8 \\ -5/2 & 6 \end{bmatrix}$

23. Given: Two sets A,B. A has 50 elements, B has 30 elements. They have 20 elements in common. How many elements are present either in A or in B but not in both?

(a) 20

(b) 30

(c) 40

(d) 50

(e) 60

24. The door of the electrically powered refrigerator in your kitchen is kept open on a hot summer day. This ----- the temperature in the kitchen:

(a) Increases

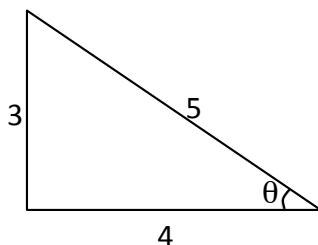
(b) Decreases

(c) Increases and then decreases

(d) Does not change

(e) None of the above

25. For the given right angled triangle, determine $\cos(\theta)$



(a) $3/5$

(b) $4/5$

(c) $5/3$

(d) $5/4$

(e) 1

26. A perfume bottle containing perfume is opened. The diffusivity of the perfume in air is D and you are standing a distance L from the bottle. Assuming diffusion is the only transport process for mass transfer, what is the characteristic time required for the perfume molecules to reach you?

- (a) L/D^2
- (b) D
- (c) L/D
- (d) D/L
- (e) L^2/D

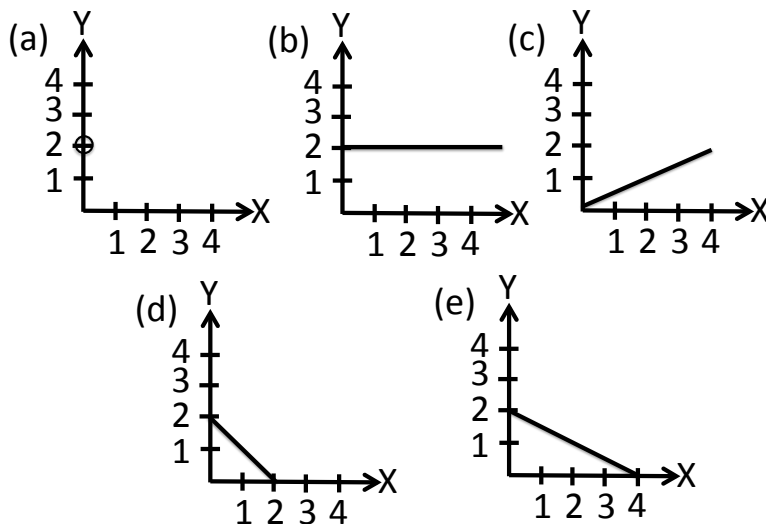
27. You are given the following differential equation: $2\frac{dx}{dt} + 3x(t) = 5u(t)$ with the initial condition: $x(0) = 0$. What is the transfer function between $u(s)$ and $x(s)$:

- (a) $\frac{5/3}{(2/3)s+1}$
- (b) $\frac{5}{2s+1}$
- (c) $\frac{5}{3s+1}$
- (d) $\frac{5}{2s^2+3s+1}$

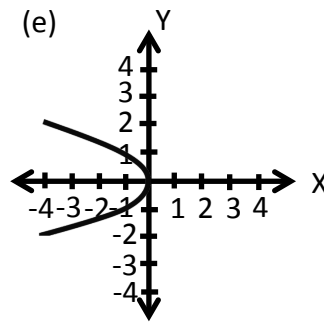
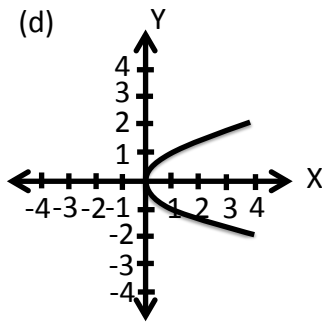
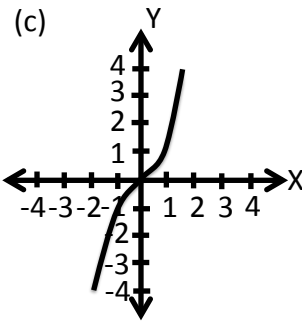
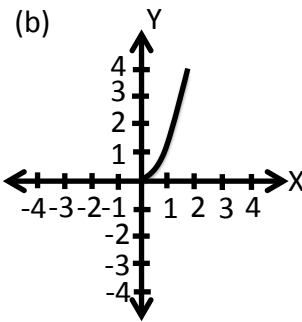
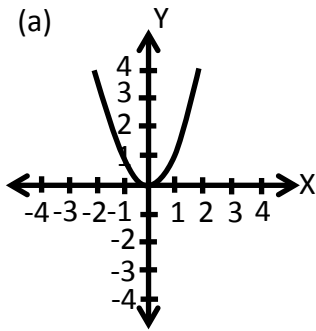
28. What are the roots of the following equation: $x^2 - 3x + 2 = 0$

- (a) 4,5
- (b) 1,2
- (c) -4, 1
- (d) -2, -1
- (e) 0, 1

29. Which of the following plot represents $y = 2$ on a x-y graph?



30. Which of the following plot represents $y = x^2$ on x-y graph?



Soln. Key

- 1) (b) 0.36
- 2) (a) 100
- 3) (d) 2.5
- 4) (c) 37
- 5) (a) $100 \times (1024)^2$
- 6) (a) No solution
- 7) (c) $a=1, b=2, c=0$
- 8) (e) Can't say anything
- 9) (c) 15!
- 10) (a) 59
- 11) (a) 1000 kg/m^3
- 12) (a) 5 hrs
- 13) (d) 9
- 14) (a) $\begin{bmatrix} 1/2 & -1/4 \\ 0 & 1/2 \end{bmatrix}$
- 15) (a) $27x^2$
- 16) (d) $2\sqrt{2}$ metres
- 17) (a) 20π metres
- 18) (a) $x^3 - 2x^2 + x - 2$
- 19) (c) $2/3$
- 20) (c) 9.8 m/s^2
- 21) (c) $\frac{\ln 2}{a}$
- 22) (b) $\begin{bmatrix} 12 & 44 \\ -6 & 3 \end{bmatrix}$
- 23) (c) 40
- 24) (a) Increases
- 25) (b) $4/5$
- 26) (c) L^2/D
- 27) (a) $\frac{5/3}{2/3 B + 1}$
- 28) (b) 1, 2
- 29) (b)
- 30) (a)