

ESE 2023 Prelims

Paper-1

Set-B

General Studies and Engineering Aptitude

ME | CE | EE | EC

Official Questions with Detailed Solutions

ESE 2023 Prelims Paper-1: Major Highlights

- **Overall Difficulty Level:** Moderate to Tough
- **Subject wise difficulty level:** Maths, ICT & Reasoning (Lengthy)
- **Theoretical & Numerical:** Almost Equal weightage
- **Assertion/Reason:** 4
- **Comparison from last year:**
Less weightage from Project Management and Standard & Quality Practices
More Weightage from Engineering Aptitude and Ethic and Values
- **Good Score:** 120+.

ESE 2023 Prelims Paper-1 : Subject-wise Weightage Distribution

S. No.	Subjects	Total Qs.	Difficulty Level
1.	Current Affairs	15	Moderate
2.	Engineering Aptitude	15	Moderate
3.	Engineering Mathematics & Numerical Analysis	15	Tough
4.	Basics of Project Management	5	Moderate
5.	Material Science	7	Moderate
6.	Ethics & Values	10	Easy
7.	Design, Drawing & Importance of Safety	8	Easy
8.	Energy & Environment	9	Moderate
9.	Information & Communication Technologies (ICT)	10	Moderate
10.	Standards and Quality Practices	6	Easy
Total		100	Moderate

ESE 2023 Prelims Paper-1 : Comparison with Last 4 Years' Data

S.No.	Subjects	2023	2022	2021	2020	2019
1.	Current Affairs	15	16	18	10	8
2.	Engineering Aptitude	15	11	15	10	10
3.	Engineering Mathematics & Numerical Analysis	15	14	15	12	5
4.	Basics of Project Management	5	9	7	9	6
5.	Material Science	7	5	7	10	9
6.	Ethics & Values	10	8	6	10	12
7.	Design, Drawing & Importance of Safety	8	8	4	12	12
8.	Energy & Environment	9	6	8	11	14
9.	Information & Communication Technologies (ICT)	10	10	10	11	10
10.	Standards and Quality Practices	6	13	10	5	14
Total		100	100	100	100	100

GENERAL STUDIES AND ENGINEERING APTITUDE

1. Six sigma gives a precision of
- A. 99.9997%
 - B. 98.4599%
 - C. 97.733%
 - D. 96.2799%

Ans. A

Sol. Six sigma gives a precision of 99.9997%

- A Six Sigma process means that 6 standard deviations fit on each side of the mean, between the mean and the specification limits.
- 6 Sigma equates in percentage terms to 99.9997% accuracy or to 3.4 defects per million opportunities to make a defect.

2. Consider the following statements with reference to six-sigma:
1. It is a methodology for structured, process oriented and systematic quality improvement.
 2. It provides a systematic approach for quality and process in improvement, rather than being just a collection of tools.
 3. It is a rigorous, data-driven, decision-making approach to analyse the root causes of problems

Which of the above statements are correct

- A. 1 and 3 only
- B. 2 and 3 only
- C. 1 and 2 only
- D. 1, 2 and 3

Ans. D

Sol.

- Six Sigma is a set of management tools and techniques designed to improve the capability of the business process by reducing the likelihood of error.
- Six sigma is a data-driven approach that uses a statistical methodology for eliminating defects, defect reduction and profits improvement.
- The five steps of Six Sigma follow an approach that industry professionals call DMAIC. This is an acronym that stands for define, measure, analyze, improve, and control.

3. As sigma level increases,
- A. cost of poor quality and customer satisfaction both go up
 - B. cost of poor quality goes up and customer satisfaction goes down
 - C. cot of poor quality goes down and customer satisfaction goes up
 - D. cost of poor quality and customer satisfaction both go down

Ans. C

Sol. • As sigma level increases, number of defects decreases which implies higher customer satisfaction and hence cost accounts for poor quality goes down.

- In other words, it has been observed that as the Sigma Level increase, the defects decrease, the indebtedness reduce and the time for rework also reduces, thus it reduces the DPMO- Defects per Million Opportunities.

4. Consider the following statements regarding the design for six-sigma:
1. The concept of six-sigma originate at Motorola.
 2. The goal is to arrive at 3.4 defects per million opportunities.
 3. Sigma is used to compare expected outcomes versus failures in a population.

Which of the above statements are correct?

- A. 1 and 2 only
 B. 2 and 2 only
 C. 1 and 3 only
 D. 1, 2 and 3

Ans. D

Sol. All are correct

- Six Sigma (Tennant, 2001) is a set of tools and techniques, developed by **Motorola** in 1986, which seek to improve the quality of process outputs by minimizing variability and identifying and removing the cause of defects.
- Sigma equates in percentage terms to 99.9997% accuracy or to 3.4 defects per million opportunities to make a defect.

5. In a plain scale, if 1.5 inches = 1 foot and it can measure upto 4 feet, what is the representative factor of the scale?

- A. $\frac{1}{8}$
 B. $\frac{1}{4}$
 C. $\frac{1}{1.5}$
 D. $\frac{2}{1.5}$

Ans. A

Sol. Given,

$$1.5 \text{ inch} = 1 \text{ foot}$$

$$\text{RF} = \frac{\text{length of drawing}}{\text{Actual length}}$$

$$\text{RF} = \frac{1.5 \text{ inch}}{1 \text{ foot}} = \frac{1.5 \text{ inch}}{12 \text{ inch}}$$


$$\text{RF} = \frac{15}{120} = \frac{5}{40} = \frac{1}{8}$$

6. Which one of the following is used when components of same shape but different dimensions are to be manufactured?


- A. Drawing for installation
 B. Tabular drawing
 C. Schematic assembly drawing
 D. Patent drawing

Ans. B

Sol. Tabular drawings are used for parts that have different dimensions but same shape for example making a pencil of different dimension i.e.

Extra long 

Standard 

Golf 

Mini Golf 

A tabulated drawing is one popular method to detail a family of similar parts. In this kind of document, varying dimension values are replaced in the drawing views by symbols (such as letter or brief description), and a table says what the measurement should be for each symbol depending on the part number.

- 7. Which one of the following lines is used to represent the outlines of adjacent parts or alternative and extreme positions of movable parts?
 - A. Continuous thick line
 - B. Continuous thin line
 - C. Chain thin double-dashed line
 - D. Dashed thin line.

Ans. C

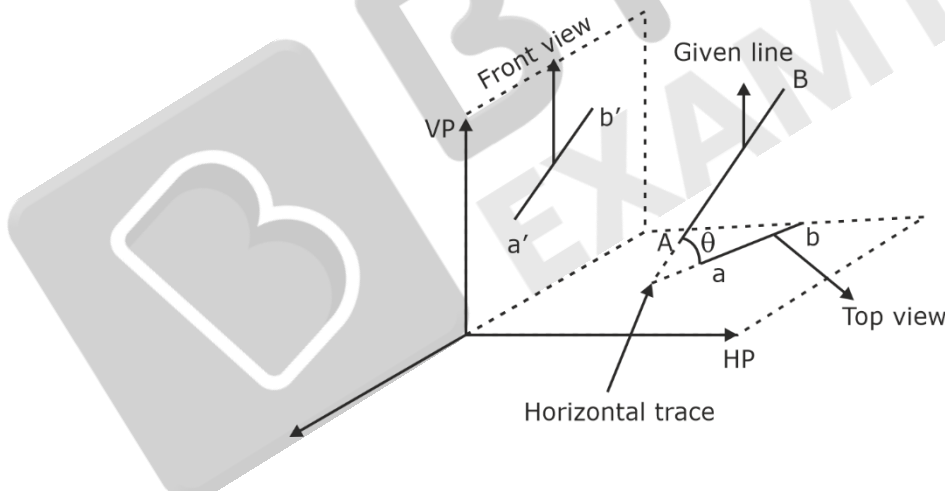
Sol. The thin chain durable dashed line is used to show adjacent components. This is especially useful when the component has a reference to the existing components.

It is also used to show alternative or extreme positions. On drawing where bends are indicated these lines are used to show the initial outlines before forming or bending. One can also use this line to indicate parts or components situated in front of the cutting plane, to give reference to the part shown.

- 8. If a line is inclined to the H.P. and parallel to the V.P., then it has.
 - A. no trace
 - B. only V.T. but no H.T.
 - C. both H.T. and V.T.
 - D. only H.T. but no V.T.

Ans. D

Sol.



When the line is inclined to one plane and parallel to other, the trace of the line is obtained only on the plane to which it is inclined, and no trace is obtained on the plane to which it is parallel.

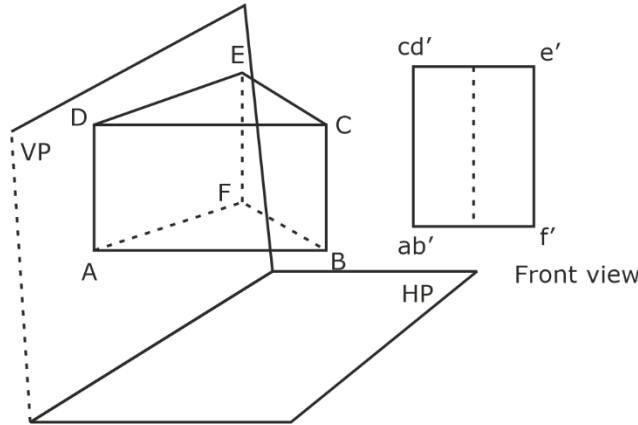
Parallel to VP, so no trace on VP

Inclined to HP, so trace on HP

- 9. A triangular prism, base 40 mm side and axis 50 mm long is resting on one of its bases on the H.P. with a vertical face perpendicular to the V.P. What is the front view of the prism?
 - A. a triangle
 - B. a rectangle
 - C. combination of two rectangles
 - D. combination of triangle and rectangle

Ans. C

Sol. Combination of two rectangles



- 10.** Consider the following points while drawing the isometric view of any solid:
1. The isometric view should be drawn according to the given views and in such a way that maximum possible details are visible.
 2. At every point for the corner of a solid, at least three lines for the edges must converge. Of these, at least two must be for visible edges.
 3. Two lines (for visible edges) will never cross each other.
- Which of the above statements are correct?
- A. 1 and 2 only B. 2 and 3 only
C. 1 and 3 only D. 1, 2 and 3

Ans. D

- Sol.** While drawing the isometric view of any solid, the following important points should be carefully noted:
- (i) The isometric view should be drawn according to the given views and in such a way that maximum possible details are visible.
 - (ii) At every point for the corner of a solid, at least three lines for the edges must converge. Of these, at least two must be for visible edges. Lines for the hidden edges need not be shown, but it is advisable to check-up every corner so that no line for a visible edge is left out.
 - (iii) Two lines (for visible edges) will never cross each other.

- 11.** Which one of the following statements is NOT correct?
- A. Notions or beliefs about manners, tastes, customs, and towards laws are few examples of morality
 - B. Morality is more general and prescriptive based on customs and traditions; whereas ethics is specific and descriptive
 - C. Morality thrusts on judgment and punishment, in the name of God or by laws; whereas ethics, thrust is on influence, education, training through codes, guidelines, and correction
 - D. Morality is more concerned with the results of wrong action, when done; whereas ethics is with the results of a right action, when not done

Ans. A

Sol.

Moral		Ethics	
1.	More general and prescriptive based on customs and traditions.	1.	Specific and descriptive. It is a critical reflection on morals.
2.	More concerned with the results of wrong action, when done.	2.	More concerned with the results of a right action, when not done.
3.	Thrust is on judgment and punishment, in the name of God or by laws.	3.	Thrust is on influence, education, training through codes, guidelines, and correction.
4.	In case of conflict between the two, morality is given top priority, because the damage is more. It is more common and basic.	4.	Less serious, hence second priority only. Less common. But relevant today, because of complex interactions in the modern society.
5.	Example: Character flaw, corruption, extortion, and crime.		Example: Notions or beliefs about manners, tastes, customs, and towards laws.

12. The 'work ethics' is aimed at NOT ensuring which of the following?

- A. The economy and productivity
- B. Safety and privacy
- C. Consumption and distribution
- D. Health and hygiene

Ans. D

Sol. Health and hygiene are about manner and manner and etiquettes. These are related to code of conduct not code of ethics.

13. Which one of the following is NOT included under the categories of civic virtues as indispensable for a self-governing administration?

- A. Self-reflection
- B. Self-restraint
- C. Self-reliance
- D. Self-assertion

Ans. A

Sol. Civic virtues are the moral duties and rights, as a citizen of the village or the country or an integral part of the society and environment.

Civic virtues are divided into four categories:

- 1. Civic Knowledge
- 2. Self-Restraint
- 3. Self-Assertion
- 4. Self-Reliance

14. Spirituality is promoted in the work-place by adhering to the following activities:

- 1. Verbally respect the individuals as humans and recognize their values in all decisions and actions.
- 2. Support causes outside the business.
- 3. Do unto others as you would have them do unto you.
- 4. Realization of the self-potential through meditative acts.

Which of the above activities are correct?

- A. 2, 3 and 4 only
- B. 1, 2, 3 and 4
- C. 2 and 3 only
- D. 1, 2 and 3 only

Ans. A

Sol. It can be verbal and non-verbal both. Hence statement-I is incorrect.

- 15.** The normative sense of engineering ethics does NOT include:
- A. Knowing moral values, finding accurate solutions to moral problems and justifying moral Judgments in engineering practices
 - B. Generating alternate courses of action to resolve the dilemma
 - C. Study of decisions, policies, and values that are morally desirable in the engineering practice and research
 - D. Using codes of ethics and standards and applying them in their transactions by engineers

Ans. B

Sol. Normative has a root word norm which means "ideal". It focuses on "what ought to be?". Something ideal cannot have alternative solutions.

Example: don't overtake from wrong side cannot have alternate solution.

Senses of Engineering Ethics:

There are two different senses (meanings) of engineering ethics, namely the Normative and the Descriptive senses.

The normative sense includes:

- (a) Knowing moral values, finding accurate solutions to moral problems and justifying moral judgments in engineering practices,
 - (b) Study of decisions, policies, and values that are morally desirable in the engineering practice and research, and
 - (c) Using codes of ethics and standards and applying them in their transactions by engineers.
- The descriptive sense refers to what specific individual or group of engineers believe an act, without justifying their beliefs or actions.

- 16.** Which of the following characteristic features distinguishes Carol Gilligan's theory from Kohlberg's theory with regard to the moral development?
- A. Transactional approach
 - B. Logic and rule centric
 - C. More of caring
 - D. Justice

Ans. C

Sol. Lawrence Kohlberg theory of moral development was criticized by Coral Gilligan as male dominated.

She said males are driven by justice based morality whereas women are driven by care based morality.

- 17.** Which of the following theorists and philosophers is NOT associated with the 'Duty Ethics'?
- A. Immanuel Kant
 - B. John Locke
 - C. John Rawls
 - D. C. W. D. Ross

Ans. B

Sol. John Locke along with Hobbes and Rousseau gave social contract theory. He was not associated with duty based ethics.

John Rawls favored social constructionistic theory of deontology. (He authored theory of justice.)

Immanuel Kant is main proponent of duty-based ethics.

C.W.D. Ross suggests that the duties of beneficence, self-improvement and justice could be subsumed under a single duty to promote intrinsic values.

18. Consider the following non-reliability performance measures of automobile industry related objects:

1. Fuel efficiency (km/l)
2. Economic efficiency (cost/kmkg⁰)
3. Quality of ride
4. Emissions (ppm)

Which of the above performance measure correct?

- A. 1, 3 and 4 only B. 1, 2 and 3 only
 C. 2, 3 and 4 only D. 1, 2, 3 and 4

Ans. D

Sol. Non reliability performance measures include Fuel efficiency, Safety ratings, Performance metrics (acceleration, top speed, and handling), Customer satisfaction (reliability, comfort, Quality of ride and features), Environmental impact (emissions and fuel consumption)

19. Match the following:

List I (Severity of failure)		List II (Impact of failure)	
P.	Catastrophic	1.	Less than minor injury or system damage
Q.	Critical	2.	Minor injury or minor system damage
R.	Marginal	3.	Result in death or total system loss
S.	Negligible	4.	Result in severe injury or major system damage

Select the correct pair using the code given below:

- | | | | | |
|----|---|---|---|---|
| | P | Q | R | S |
| A. | 3 | 4 | 2 | 1 |
| B. | 4 | 3 | 1 | 2 |
| C. | 2 | 1 | 3 | 4 |
| D. | 1 | 2 | 4 | 3 |

Ans. B

List I (Severity of failure)		List II (Impact of failure)	
P.	Catastrophic	4.	Result in severe injury or major system damage
Q.	Critical	3.	Result in death or total system loss
R.	Marginal	1.	Less than minor injury or system damage
S.	Negligible	2.	Minor injury or minor system damage

20. Consider the following statements for the multi-state characterization (infinite number of states) with $K = \infty$.

1. $X(t)$ is non-decreasing.
2. $X(t)$ is continuous-time stochastic process.
3. Higher value of $X(t)$ implies greater degradation and the item failure time.

Which of the above statements are correct?

- A. 1 and 2 only B. 2 and 3 only
 C. 1 and 3 only D. 1, 2 and 3

Ans. D

Sol. With $K = \infty$. $X(t)$ is now a

1. Non-decreasing, continuous- time stochastic process, as shown in Figure
2. A higher value of $X(t)$ implies greater degradation, and the item failure time is given by $T = \inf\{t: X(t) = x^*\}$

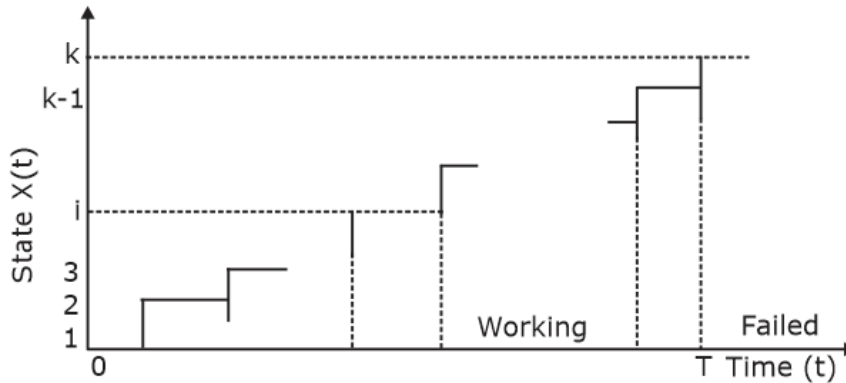


Figure: Time to failure. (multi-state characterization with a finite number of states.)

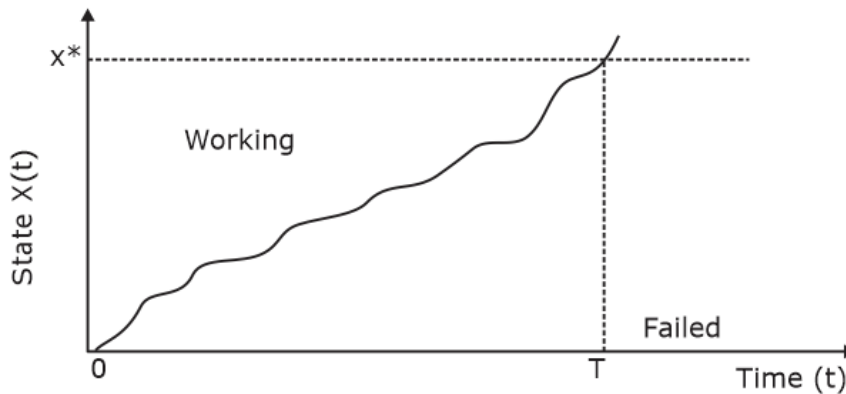


Figure: Time to failure. (multi-state characterization with an infinite number of states.)

- 21.** Which one of the following does NOT always yield an optimal schedule, however it is capable of yielding a "good" schedule for very complex networks having many types of resources?
- | | |
|--------------|---------------|
| A. Algorithm | B. Optimum |
| C. Backhoes | D. Heuristics |

Ans. D

Sol. Heuristics do not always yield an optimal schedule, but they are very capable of yielding a good schedule for very complex networks with many types of resources.

- 22.** According to CCPM, using 50/50 estimates will discourage Parkinson's law, the student syndrome, and self- protection from coming into play because there is less "free time" available. What does the abbreviation CCPM stand for?
- A. Control Chain – Project Management
 - B. Creating Chain – Project Management
 - C. Computer Control – Project Management
 - D. Critical Chain – Project Management

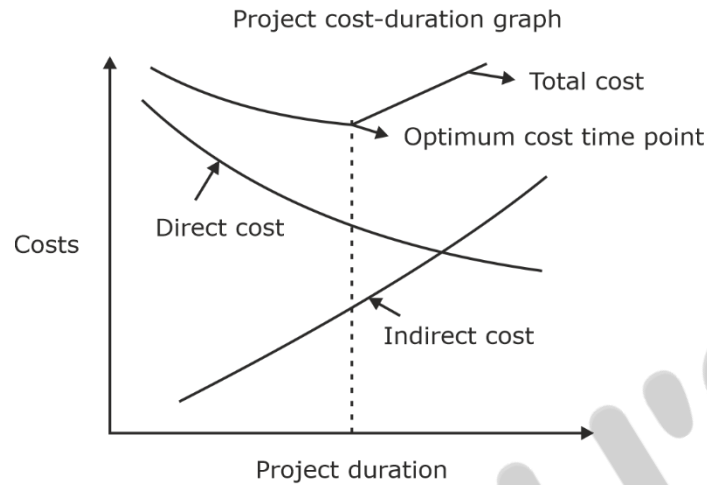
Ans. D

Sol. CCPM: Critical chain project management.
 (CCP is supposed to supersede critical path method CCPM) with its capability to deliver projects on time.
 CCPM approach recognizes the specific behaviour consisting of refining the work.

23. According to project cost-duration graph, any reduction in project duration means a reduction in
- A. direct costs
 - B. indirect costs
 - C. total costs
 - D. optimum costs

Ans. B

Sol.



According to project-duration graph, any reduction in project duration mean's a reduction in direct

24. When a pair of one cation and one anion are absent from an ionic crystal, then the defect is called
- A. Schottky's defect
 - B. Frenkel's defect
 - C. Cross-slip defect
 - D. Stacking defect

Ans. A

Sol. Schottky defect is a type of point defect or imperfection in solids caused by a vacant position in a crystal lattice caused by atoms or ions moving out from the crystal's interior to the surface.

25. The diffusion coefficient for copper in aluminium at 500°C and 600°C are $4.8 \times 10^{-14} \text{ m}^2/\text{s}$ and $5.3 \times 10^{-3} \text{ m}^2/\text{s}$ respectively. What is the approximate time at 500°C that will produce the same diffusion result (in terms of concentration of copper at some specific point in aluminium) as 10 h heat treatment at 600°C ?
- A. 110.4 h
 - B. 152.4 h
 - C. 210.4 h
 - D. 252.4 h

Ans. *

Sol. $D \times t = \text{constant}$

$$D_1 t_{500} = D_2 t_{600}$$

$$= \frac{5.3 \times 10^{-3} \times 10}{4.8 \times 10^{-14}}$$

wrong data

26. A relatively large plate of a glass is subjected to a tensile stress of 40 MPa. If the specific surface energy and modulus of elasticity for this glass are 0.3 J/m² and 69 GPa, respectively, what is approximate maximum length of a surface flaw that is possible without fracture ?
- A. 6.2 μm
 - B. 8.2 μm
 - C. 10.2 μm
 - D. 12.2 μm

Ans. B

Sol. According to Brittle fracture,

$$\sigma_c = \left(\frac{2 E r_s}{\pi a} \right)^{1/2}$$

E → Modulus of elasticity

a → Length of surface flaws

r_s → specific surface energy

$$a = \frac{2 E r_s}{\pi \sigma_c^2}$$

$$= \frac{2 \times (69 \times 10^9) \times 0.3}{\pi \times (40 \times 10^6)^2}$$

$$= 8.2 \mu\text{m}$$

27. A piece of copper originally 305 mm long is pulled in tension with a stress of 276 MPa. If the deformation is entirely elastic, what is the resultant elongation approximately ?

- A. 3.3 mm
- B. 0.33 mm
- C. 0.77 mm
- D. 7.7 mm

Ans. C

Sol. L = 305 mm

σ = 276 MPa

E = 1110

$$\epsilon = \frac{\sigma}{E} = \frac{276}{110 \times 10^3}$$

$$\delta = \epsilon \times 305 = 0.765 \approx 0.77 \text{ mm}$$

28. What is the approximate value of ductility (%EL) of a cylindrical copper rod if it is cold worked such that the diameter is reduced from 15.2 mm to 12.2 mm ? (Take the tensile strength from the curve for copper as 340 MPa)

- A. 7%
- B. 3.56%
- C. 70%
- D. 35.6%

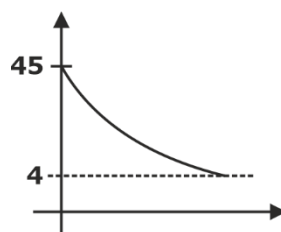
Ans. B

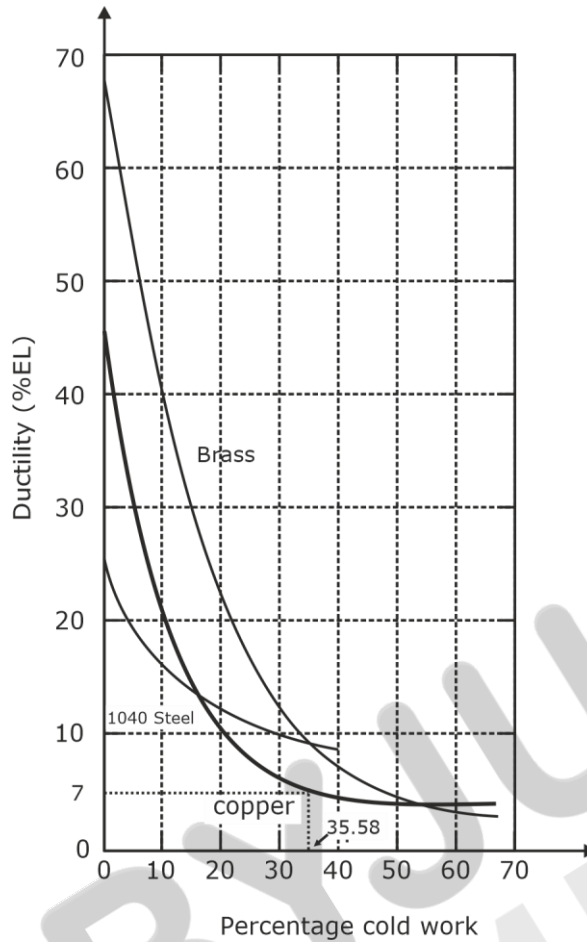
Sol. Percentage of cold working = $\frac{A_0 - A_f}{A_0} \times 100$

$$= 35.58\%$$

Tensile strength of copper = 340 MPa

Ductility = 3.56 from curve





29. The density of α - Fe is $7.87 \times 10^3 \text{ kg/m}^3$. Atomic weight of Fe is 55.8. If α - Fe crystallises in BCC space lattice, what is the lattice constant approximately ? (Take Avogadro's number (N) = $6.02 \times 10^{26}/\text{kg/mole}$ and number of atoms per unit cells is 2)

- A. 0.666 Å
- B. 1.766 Å
- C. 2.866 Å
- D. 3.966 Å

Ans. C

Sol. $\rho_v = \frac{N_{\text{avg}} \times \text{atomic weight}}{N_{\text{AVG}} \times \text{Vol.}}$

$$7.87 \times 10^3 = \frac{2 \times 55.8 \times 10^{-3}}{6.023 \times 10^{23} \times a^3}$$

$$a^3 = \frac{2 \times 55.8 \times 10^{-3}}{6.023 \times 10^{26} \times 7.87 \times 10^3}$$

$$a^3 = 2.354 \times 10^{-3-26-3}$$

$$a = 2.866 \times 10^{-10} = 2.866 \text{ \AA}$$

30. Which one of the following statements is related to frequency hopping spread spectrum?

- A. It is a spread spectrum technique which allows for the coexistence of multiple networks in the same area by separating different networks using different hopping sequences
- B. It is a spread spectrum technique which allows for the coexistence of multiple networks in the different area by separating different networks using different hopping sequences

- C. It is a spread spectrum technique which does not allow for the coexistence of multiple networks in the same area by separating same networks using different hopping sequences
- D. It is a spread spectrum technique which allows for the coexistence of single network in the different area by separating different networks using same hopping sequence

Ans. A

Sol. Frequency hopping spread spectrum allows coexistence of multiple networks in same area by using different hopping sequence.

31. Which one of the following scientists called entropy time arrow ?

- A. Thomas Young
- B. Arthur Eddington
- C. Max Planck
- D. Thompson

Ans. B

Sol. When an event occurs anywhere in the world, energy is expended, and the overall entropy increases. To say the world is out of time is also to say the world is out of usable energy. 'Entropy is the arrow of time,' is said Sir Arthur Eddington.

32. Consider the following statements :

Energy balances are fundamental for energy planning, since they allow analysing aspects such as :

- 1. distribution of final energy consumption per end-use sector.
- 2. storage and refinement of each fuel or group of energies in the matrix.
- 3. self-sufficiency in energy, foreign dependence and foreign trade.
- 4. efficiency in processes for transforming primary energy into secondary.

Which of the above statements is/are NOT correct?

- A. 2 only
- B. 1 and 2 only
- C. 1, 2 and 3 only
- D. 4 only

Ans. A

Sol. Energy balances are essential tools for energy planning because they allow for the analysis of several aspects related to Energy supply and demand, Energy efficiency, Energy costs, Energy emissions, Energy security

33. Which one of the following is NOT an advantage of energy efficiency ?

- A. The cost of energy economy is usually smaller than that of its generation
- B. Security of supply increases and resources which are finite are saved.
- C. There are micro and macro economic gains associated with an increase in productivity and in industrial competitiveness
- D. The access to energy services is decreased

Ans. D

Sol. Energy efficiency is vital to improving energy access globally, especially in emerging economies where there is increasing energy demand. As they asked not an advantage answer will be D

34. The British economist Nicholas Stern gave the most impressive analysis in the year 2006 on

- A. Ozone layer depletion
- B. Renewable energy sources
- C. Climate change
- D. Deforestation

Ans. *

Sol. The Stern Review on the Economics of Climate Change is a 700-page report released for the Government of the United Kingdom on 30 October 2006 by economist Nicholas Stern.

- 35.** Consider the following factors determining the evolution of energy intensity :
1. dematerialization
 2. fuel use intensity
 3. recycling
- Which of the above factors is/are correct?
- A. 1, 2 and 3
B. 2 and 3 only
C. 1 and 3 only
D. 3 only

Ans. A

Sol. Key Correction required option has to be 1 and 2 only Out of the three statements provided, two of them, namely "fuel use intensity" and "dematerialization," are relevant to determining the evolution of energy intensity. While recycling can help conserve natural resources and reduce environmental impacts, it does not directly impact energy intensity, which is specifically related to the amount of energy required to produce a unit of output.

- 36.** Surface rocks on Earth are cool, but below the surface the temperature increases with depth. This is called
- A. the geothermal gradient
B. the homogeneous accretion
C. the pangaea
D. the mesocrates

Ans. A

Sol. The geothermal gradient is the amount that the Earth's temperature increases with depth. It indicates heat flowing from the Earth's warm interior to its surface. On average, the temperature increases by about 25°C for every kilometer of depth.

- 37.** Which one of the following is NOT correct?
- A. The formation of a mountain chain by the compression of crustal rocks is known as an orogeny
B. Rock between the two extremes is called mesocratic
C. Sediments are deposited in horizontal layers called clay plates
D. Particles deposited as sediments are changed into rock by the pressure of later deposits at low temperature is called diagenesis

Ans. C

Sol. Orogeny, or mountain building, is the result of the collision between two landmasses. This may occur via the collision of continental crust (continent-continent collision) or when oceanic and continental crust collide (ocean-continent collision).

Mesocratic —applied to rocks composed of approximately equal proportions of light-colored and dark-colored minerals

Diagenesis is defined as the sum of physical, chemical, and biochemical changes that affect sediment after it has been deposited and during or after its lithification.

- 38.** Consider the following statements for hammock activities:
1. It derives its name because it spans over a segment of a project.
 2. The hammock activity duration is determined after the network plan is not drawn.
 3. The hammock activities are frequently used to identify the use of fixed resources or costs over a segment of the project.
 4. The maximum amount of time an independent activity must be delayed to begin or end.
- Which of the above statements are correct?
- A. 2 and 3 only
B. 1 and 3 only
C. 1 and 4 only
D. 2 and 4 only

Ans. B

Sol. Hammock activity is a schedule or project planning term for grouping smaller sub tasks that hang between two dates.

Hammock activity derives its name because it spans over a segment of a project.

The hammock activity duration is determined after the network plan is drawn.

The hammock activities are frequently used to identify the use of fixed resources or costs over a segment of the projects.

39. Consider the following strategies for mitigating risk under risk response development:

1. Reduce the likelihood that the event will occur
2. Reduce the impact that the adverse event would have on the project
3. Analyse the project to identify sources of risk
4. Assess risks in terms of severity of impact

Which of the above strategies are correct?

- | | |
|-----------------|-----------------|
| A. 1 and 2 only | B. 3 and 4 only |
| C. 1 and 4 only | D. 2 and 3 only |

Ans. A

Sol. The following strategies for mitigating risk under risk response development:

The ultimate purpose of risk identification and analysis is to prepare for risk mitigation which includes reduction of the likelihood that a risk event will occur or reduction of the effect of a risk event if the latter does occur.

40. Consider the following statements:

The strategy is to assign extra time at critical moments in the project, buffers are added to:

1. activities with no risk.
2. merge activities that are prone to delays due to one or more preceding activities being late.
3. non-critical activities to reduce the likelihood that they will create another critical path.
4. activities that require scarce resources to ensure that the resources are available when needed.

Which of the above statements are correct?

- | | |
|--------------------|---------------------|
| A. 1, 2 and 3 only | B. 1, 2 and 4 only. |
| C. 2, 3 and 4 only | D. 1, 3 and 4 only |

Ans. C

Sol. 2, 3 & 4 statements are correct.

The strategy is to assign extra time at critical moments in the project, buffers are added to:

- merge activities that are prone to delays due to one or more preceding activities being late.
- non-critical activities to reduce the likelihood that they will create another critical path.
- activities that require scarce resources to ensure that the resources are available when needed.

41. Which one of the statements is NOT relevant to quantum computing?

- A. Quantum computing is that much more powerful functions may be computed using qubits and quantum gates
- B. Quantum operations are well adapted to describe discrete state changes, that is, transformations between an initial state and final state, without explicit reference to the passage of time
- C. Quantum computation does not support entanglement measurements of a quantum computer's registers can yield only a small, discrete set of values
- D. Quantum computing is the use of quantum phenomena such as superposition and entanglement to perform the computation

Ans. C

Sol. The statement C is incorrect as entanglement is the heart of quantum computers. It makes computer very powerful.

42. A device which exhibits irregular or unpredictable response times is called

- A. Asynchronous
- B. Synchronous
- C. Sharable
- D. Non-sharable

Ans. A

Sol. Asynchronous device performs data transfer with predictable response time. An asynchronous device exhibits irregular or unpredictable response time.

43. Which one of the following tables is used by operating system to keep the track of many I/O requests at the same time?

- A. File allocation table
- B. Device – status table
- C. Memory – status table
- D. Interrupt driven table

Ans. B

Sol. Device status table contains entry for each I/O device indicating its type, address, and data. Operating system indexes into I/O device table to determine device status and to modify table entry to include interrupt. Thus option B is the correct answer.

44. A stream of a video image that is one-quarter the size of a standard TV image; that is, it has a resolution of 352 by 240 pixels. If each pixel is represented by 24 bits of information, as would be the case for 24-bit color, then what is the approximate size of each frame?

- A. 247.5 KB
- B. 352.5 KB
- C. 417.5 KB
- D. 532.5 KB

Ans. A

Sol. Size of each frame = Number of pixels × color depth

Number of pixels = $352 \times 240 = 84,480$

Color depth = 24 bits (given)

Size of frame = $84,480 \times 24 = 2,027,520$ bits

⇒ 253,440 bytes

So, $\frac{253.440}{1024}$ K Bytes = 247.5 KB

So, Option A is correct.

45. What is the approximate effective throughput, if user wants to fetch a 1-MB file across a 1-Gbps network with a round-trip time of 100 ms?

- A. 50.1 Mbps
- B. 74.1 Mbps
- C. 84.1 Mbps
- D. 90.1 Mbps

Ans. B

Sol. Given file size = 1 MB

Round trip time = 100 ms

Here, the user wants to fetch a 1 MB files across the 1 Gbps network with the RTT of 100 ms.

This includes both the transmit time for 1 MB.

$R = 1/1 \text{ Gbps} \times 1 \text{ Mbps}$

So, the total transfer time = $100 + 8 = 108$ ms

Hence, the effective throughput = $1 \text{ MB}/108 \text{ ms} = 74.1 \text{ Mbps}$

- 46.** In a network, a transcontinental channel with a one-way latency of 50 ms and a bandwidth of 45 Mbps is able to hold how many bits that fit in the pipe approximately?
- A. 2.25×10^6 bits
 - B. 1.25×10^6 bits
 - C. 50.00×10^6 bits
 - D. 45.00×10^6 bits

Ans. A

Sol. Number of bits that fit in the pipe = latency \times bandwidth
= $50 \times 10^{-3} \times 45 \times 10^6$ bits
= 2250×10^3 bits
= 2.250×10^6 bits

- 47.** Consider the following statements for significance of prominence in the Internet architecture:
1. Programmers are free to define new channel abstractions or applications that run on top of any of the existing protocols.
 2. It defines a common method for exchanging packets among a wide collection of networks.
 3. It allows someone to propose a new protocol to be included in the architecture.
- Which of the above statements, is/are correct?
- A. 1 only
 - B. 2 and 3 only
 - C. 1 and 3 only
 - D. 1, 2 and 3

Ans. D

Sol. The prominence in the internet architecture means that programmes have the freedom to define new channel abstractions or applications that run on the top of any of the existing protocols. This flexibility allows for innovation and growth in the network. The internal architecture defines a common method for exchanging packets among a wide collection of network. This common method is based on standard protocols which enables devices from different vendors to communicate with each other. The prominence in the internet architecture allows anyone to propose a new protocol to be included in the architecture. This feature encourages innovation and allows for the development of new or more efficient protocols that can be enhanced the performance of the network.

- 48.** Consider the following statements regarding the failure in the network:
1. Bit errors typically occur because outside forces, such as lightning strikes, power surges, and microwave ovens, interfere with the transmission of data.
 2. One of the main difficulties in dealing with lost packets is distinguishing between a packet that is indeed lost and one that is merely late in arriving at the destination.
 3. The failure can be caused by software that crashes, a power failure, or a reckless backhoe operator.
- Which of the above statements is/are correct?
- A. 1 only
 - B. 1 and 2 only
 - C. 2 and 3 only
 - D. 1, 2 and 3

Ans. D

Sol. Bit errors occurs due to outside forces, such as lighting strikes, power surand microwave ovens, interfere with data transmission of data. One of the difficulties in dealing with lost packets is distinguishing between a packet that is indeed lost and one that is merely late in arriving at the destination. Network failure can be caused by a variety of factors including software crash, power failure and physical damage to network caused by accidents or human errors.

- 49.** Which one of the following statements is NOT correct regarding human values?
- Values mean an in-built mechanism which distinguishes the right from the wrong
 - Values provide us with a unique, personal, and moral template that we use subconsciously to assess and judge the intentions and actions of others and ourselves
 - Values serve the process of 'becoming' in the sense of transformation of the level of consciousness to purer, higher levels
 - Values are essentially objective while skills are subjective

Ans. D

Sol. Values are highly subjective.

- 50.** Consider the following objectives of the study on professional ethics:
- Forming consistent viewpoints based on facts
 - Searching beyond obvious the alternative responses to issues and being receptive to creative solutions
 - Comprehending, assessing different views

Which of the above objectives is/are correct?

- | | |
|-----------------|-----------------|
| A. 2 and 3 only | B. 1, 2 and 3 |
| C. 2 only | D. 1 and 3 only |

Ans. B

Sol. Improvement of the cognitive skills (skills of the intellect in thinking clearly)

- Moral awareness (proficiency in recognizing moral problems in engineering)
- Cogent moral reasoning (comprehending, assessing different views)
- Moral coherence (forming consistent viewpoints based on facts)
- Moral imagination (searching beyond obvious the alternative responses to issues and being receptive to creative solutions)
- Moral communication, to express and support one's views to others.

- 51.** Which one of the following is NOT included in the 12 areas of "Doing Business 2020"?

- | | |
|--------------------------------------|-------------------------|
| A. Getting credit. | B. Paying taxes. |
| B. Promoting small scale industries. | D. Getting electricity. |

Ans. C

Sol. Areas of doing business 2020

- Starting a Business
- Dealing with Construction Permits
- Getting Electricity
- Registering Property
- Getting Credit
- Protecting Minority Investors
- Paying Taxes
- Trading Across Borders
- Enforcing Contracts
- Resolving Insolvency
- Empowering Workers
- Paying Taxes

52. Consider the following economic activities:

1. Public administration
2. Financial services
3. Mining and quarrying

Which of the above economic activities fall under the tertiary sector?

- | | |
|-----------------|-----------------|
| A. 1 and 3 only | B. 1, 2 and 3 |
| C. 2 and 3 only | D. 1 and 2 only |

Ans. D

Sol. The various activities have been classified into three main sectors i.e., primary, secondary, and tertiary. Primary sector includes agriculture, forestry, animal husbandry, fishing, poultry farming, and mining. Quarrying and manufacturing is included in the secondary sector. Trade, transport, communication, banking, education, health, tourism, services, insurance etc. are included in the tertiary sector.

53. IMF raises its projection for economic growth in 2021-22 to

- | | |
|----------|----------|
| A. 11.3% | B. 12.5% |
| C. 10.2% | D. 8.4% |

Ans. A

Sol. In 2021 – 6.8% and 2022 – 4.5%
Total 11.3%

54. Consider the following statements:

1. Ford India will stop manufacturing vehicles in India but-will retain the engine-making and technology services business as part of restructuring its India operations.
2. Zee Entertainment Enterprises Ltd announces a merger with Sony Pictures Networks India.
3. Yashoda Hegde is the new CEO of Coffee Day Enterprises Ltd.

Which of the above statements is/are correct?

- | | |
|-----------------|-----------|
| A. 1 and 3 only | B. 1 only |
| C. 1 and 2 only | D. 2 only |

Ans. C

Sol. 1. Ford India will stop manufacturing vehicles in India but-will retain the engine-making and technology services business as part of restructuring its India operations.
2. Zee Entertainment Enterprises Ltd announces a merger with Sony Pictures Networks India.
3. Mrs. Malavika Siddhartha Hegde is the new CEO of Coffee Day Enterprises Ltd.

55. Government of India has moved a resolution in UN General Assembly to declare the year 2023 as the International Year of Millets for which of the following reasons?

1. Support will be provided for post-harvest value addition, enhancing domestic consumption.
2. Support will be provided for branding millet products nationally and internationally.

Select the correct answer using the code given below:

- | | |
|-----------------|--------------------|
| A. 1 only | B. Neither 1 nor 2 |
| C. Both 1 and 2 | D. 2 only |

Ans. C

Sol. Statement 1 is correct.

Department of Agricultural Research and education will conduct Studies about Value Addition of Millets.

Statement 2 is correct.

The Agricultural and Processed Food Products Export Development Authority (APEDA) will exhibit the diversity of Indian millets at a trade show in Belgium. Indian embassies in over 140 countries will celebrate IYM in 2023 by hosting side events involving the Indian diaspora through exhibitions, seminars, talks, and panel discussions.

56. 'Bahujan Hitaya : Bahujan Sukhaya' is the motto of

- A. Central Board of Film Certification
- B. Indian Railways
- C. Doordarshan
- D. All India Radio

Ans. D

Sol. Since its inception, All India Radio (AIR) has served to inform, educate, and entertain the masses, truly living up to its motto 'Bahujan Hitaya: Bahujan Sukhaya'.

57. Statement (I): The machine shop produces parts machined from stock material and finishes castings, forgings, etc., requiring machined surfaces.

Statement (II): In machine shops, machining operations remove metal, either to make a smoother and more accurate surface, as by planning, facing, milling, etc. or to produce a surface previously existing, as by drilling, punching, etc.

- A. Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- B. Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)
- C. Statement (I) is true but Statement (II) is false
- D. Statement (I) is true but Statement (II) is true

Ans. A

Sol. Both the statements are correct, and statement (I) is correct explanation of statement (II)

58. Statement (I) : Ozone depletions are mostly harmful to biological systems in a variety of ways.

Statement(II): Ozone depletion in stratosphere leads to the loss of filtering ability of UV light.

- A. Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- B. Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)
- C. Statement (I) is true but Statement (II) is false.
- D. Statement (I) is false but Statement (II) is true

Ans. A

Sol. The increased levels of UV radiation reaching the Earth's surface due to ozone depletion have been linked to a range of negative health effects, including skin cancer, cataracts, and immune system suppression.

Based on several studies and paper titled "Projected increase in UV radiation in the United States due to ozone depletion and climate change" and was published in Environmental Research Letters in 2019.

Yes, ozone depletion in the stratosphere leads to a loss of filtering ability of UV light

59. Statement (I): Alterations in both, physico-chemical(abiotic) and biological (biotic) components of the biosphere by mankind resulted in environmental degradation world over.

Statement(II) : Major environmental problems are in fact the manifestations of the degraded environments at global level.

- A. Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- B. Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)
- C. Statement (I) is true but Statement (II) is false.
- D. Statement (I) is false but Statement (II) is true

Ans. B

Sol. Alterations in Physiologic, Hematologic, Hormonal, and Biochemical Parameters in Humans Restricted for a 2-Year Period as they result to environment degradation

60. Statement (I): Ethics involves the discipline of systematic enquiry into moral norms of standards of behavior and their underlying values and justification.

Statement (II): Applied ethics looks into the ways in which moral value can be applied to particular areas of concern such as business.

Codes:

- A. Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- B. Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)
- C. Statement (I) is true but Statement (II) is false
- D. Statement (I) is false but Statement (II) is true

Ans. B

Sol. Ethics is the standard principles in decision making related to right or wrong. Applied ethics is about ethical issue in a specific field of study.

61. What is the correct alternative for the question mark?

2, 3, 8, 63, ?

- A. 1038
- B. 1998
- C. 3008
- D. 3968

Ans. D

Sol. 2, 3, 8, 63, ?

Rule followed:

$$a_n = (a_{n-1})^2 - 1$$

$$3 = 2^2 - 1$$

$$8 = 3^2 - 1$$

$$63 = 8^2 - 1$$

The next number will be = $63^2 - 1 = 3968$

- 62.** Which one of the following is NOT an objective of Mahila Kisan Sashaktikaran Pariyojana (MKSP)?
- A. To create sustainable agricultural livelihood opportunities for women in agriculture.
 - B. To ensure food and nutrition security at the household and the community level.
 - C. To enable women to have better access to inputs and services of the government and other agencies.
 - D. To help women, educate the rural folk and improve their living condition.

Ans. D

Sol. Specific objectives of MKSP are as under:

- To enhance the productive participation of women in agriculture.
- To create sustainable agricultural livelihood opportunities for women in agriculture.
- To improve the skills and capabilities of women in agriculture to support farm and non-farm-based activities.
- To ensure food and nutrition security at the household and the community level.
- To enable women to have better access to inputs and services of the government and other agencies.
- To enhance the managerial capacities of women in agriculture for better management of bio-diversity.
- To improve the capacities of women in agriculture to access the resources of other institutions and schemes within a convergence framework.

- 63.** Consider the following statements regarding the aim of Jal Jeevan Mission to provide every rural household of the country with adequate tap water of prescribed quality on regular basis:
1. It seeks to ensure 'ease of living' which leads to healthier as well as hygienic living conditions in rural areas.
 2. It aims to establish water tanks in good numbers with the slogan 'Har Ghar Jal'.
 3. By ensuring community participation at village-level, it will help in developing local leadership based on Gandhiji's philosophy of 'Gram Swarajya'.
 4. The Mission seeks to achieve its goal by 2024.

Which of the above statements are correct?

- A. 1, 3 and 4 only
- B. 1, 2, 3 and 4
- C. 1 and 3 only
- D. 2 and 4 only

Ans. A

Sol. Har Ghar Jal (Water to Every Household) is a scheme launched in 2019 by the Ministry of Jal Shakti of the Government of India under the Jal Jeevan Mission with the goal of providing tap water to every rural household by 2024.

JJM provides an opportunity to local communities to take up water quality surveillance in their villages. In every village, five persons, especially women are being trained on various aspects of potable water and use of Field Test Kits (FTKs) to test quality of water supplied, conduct sanitary surveys, and upload the data on JJM portal. So far, more than 7 lakh women have been trained to use FTKs. All these initiatives are in line with Mahatma Gandhi's vision of 'Gram Swaraj', wherein the village community is vested with decision making powers.

"Jal Jeevan Mission is in line with schemes launched for ordinary people, all aimed at ease of living so that they can think beyond basic amenities...I am confident that we will achieve JJM target of taking drinking water to every rural home." -OPEN Magazine Vol-11 | Issue 73, The Future of Water.

- 64.** Which one of the following is NOT correctly matched?
- A. The Last Queen: Chitra Banerjee Divakaruni
 - B. Inseparable: Simone de Beauvior
 - C. Great Circle: Rumaan Alam
 - D. Jungle Nama: Amitav Ghosh

Ans. C

Sol. Great Circle is a Novel by Maggie Shipstead.

- 65.** What is 'The Pandora Papers'?
- A. It is the document related to the top 100 highest taxpayers of the world.
 - B. It is the project of investigation which leaked almost 12 million documents that reveals hidden wealth, money laundering by some of the world's rich and powerful.
 - C. It is the record of total revenue collected at the world level.
 - D. It is the document containing record of the top young talented entrepreneurs under the age 30.

Ans. B

Sol. The Pandora Papers is a 2021 leak nearly 12 million documents incriminating hundreds of global politicians and wealthy elite for tax avoidance and corruption. The papers details how such individuals sheltered money in offshore accounts, shell companies, and real estate investments.

- 66.** Match the following:

List-I

- P. V Shanta
- Q. Akhtar Ali
- R. Anil Dharkar
- S. Sumitra Bhave

List-II

- 1. Film director
- 2. Former Davis cup coach
- 3. Noted journalist
- 4. Renowned Indian oncologist

Select the correct pair using the code given below:

P	Q	R	S
A.	4	2	3
B.	2	4	1
C.	3	1	2
D.	1	3	4

Ans. A

Sol. 1. Dr.V. Shanta was an undisputed cancer crusader in the oncologic landscape for the past six decades.

2. Akhtar Ali, was an Indian tennis player. He was a member of the Indian Davis Cup team continuously from 1958 to 1964 and captain of Indian Davis Cup in 2008.

3. **Anil Dharker** (1947-26 March 2021) was an Indian journalist and writer. He was the founder and director of the Mumbai International Literary Festival.

4. **Sumitra Bhave** and Sunil Sukthankar were an Indian filmmaker duo working predominantly in Marathi cinema.

- 67.** Select the State/s and/or UTs of India which have been ranked first as 'Zero Hunger' as per SDF: India Agenda for Development:
- A. Tamil Nadu and Delhi
 - B. Kerala and Chandigarh
 - C. Gujarat and Delhi
 - D. Goa and Lakshadweep

Ans. B

Sol. Kerala as a state is ranked first
Chandigarh as a union territory is ranked first.

68. Which one of the following pairs is NOT correct under women achievers?
- A. Megha Rajagopalan: Winner of Pulitzer Prize in feature writing
 - B. Anvee Bhutani: Indian-origin student elected as the President of Oxford Student Union.
 - C. Delisha Davis: 24 year old female heavy vehicle driver carrying hazardous goods.
 - D. Bela M Trivedi: Took oath as the Judge of the Supreme Court of India.

Ans. A

- Sol. 1. Jennifer Senior of The Atlantic winner of Pulitzer prize in feature writing.
2. Indian-Origin Anvee Bhutani Elected Oxford Student Union President in Byelection.
3. Delisha Davis, who was passionate about driving from an early age, is now driving her father's tanker truck loaded with hazardous goods.
4. Bela Madhurya Trivedi is a judge of the Supreme Court of India. She had previously been a judge of the Gujarat High Court since 9 February 2016.

69. Who among the following is India's first Space Tourist?
- A. Santhosh George Kulangara
 - B. Sirisha Bandla
 - C. Raja J V Chari
 - D. Pankaj Lokhani

Ans. A

- Sol. **Santosh George Kulangara** was the person in India to go in space as a space tourist after paying a whopping \$ 200,000 and booked a seat in Virgin Galactic. Santosh George is a resident of Kerala.

70. The Wassenaar Arrangement is
- A. an elite club of countries which subscribe to arms export controls.
 - B. a group of countries concerned with unconventional energy sources in the world.
 - C. concerned with the preservation of extinct animal species.
 - D. an arrangement which seeks to study recurring cyclone patterns.

Ans. A

- Sol. The Wassenaar Arrangement is an elite club of countries which subscribe to arms export controls, like the Nuclear Suppliers Group and the Missile Technology Control Regime.

71. For what values of a and b is the vector field $F = (x + z)\hat{i} + a(y + z)\hat{j} + b(x + y)\hat{k}$ a conservative field?
- A. $a = b = 1$
 - B. $a = b = -1$
 - C. $a = 1, b = -1$
 - D. $a = -1, b = 1$

Ans. A

Sol. Given,

$$\vec{F} = (x + z)\hat{i} + a(y + z)\hat{j} + b(x + y)\hat{k}$$

For conservative / Irrotational field

$$\text{Curl } \vec{F} = \nabla \times \vec{F} = 0$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ (x + z) & a(y + z) & b(x + y) \end{vmatrix} = 0$$

$$\hat{i} \left[\frac{\partial}{\partial y} b(x+y) - \frac{\partial}{\partial z} a(y+z) \right] - \hat{j} \left[\frac{\partial}{\partial x} b(x+y) - \frac{\partial}{\partial z} (x+z) \right]$$

$$+ \hat{k} \left[\frac{\partial}{\partial x} a(y+z) - \frac{\partial}{\partial y} (x+z) \right] = 0$$

$$\Rightarrow \hat{i}[b-a] - \hat{j}[b-1] + \hat{k}[0-0] = 0$$

$$\Rightarrow (b-a)\hat{i} + \hat{j}(1-b) + 0\hat{k} = 0$$

$$b-a = 0 \text{ and } 1-b = 0$$

$$a = b \text{ and } b = 1$$

$$\Rightarrow a = b = 1$$

72. Let S be the surface of the paraboloid of revolution $z = 1 - x^2 - y^2$ with the domain of definition $x^2 + y^2 \leq 1$, and let Γ be the boundary of the paraboloid.

Given

$F = x^3 \hat{i} + (x + y + z) \hat{j} + yz \hat{k}$. What is the value of $\iint_S \text{curl } F \cdot d\mathbf{S}$?

- A. 2π
- C. $\frac{\pi}{2}$

- B. π
- D. π^2

Ans. *

73. The fixed point iterative scheme for determining $\sqrt{2}$ is

A. $x_{n+1} = \frac{1}{2} \left(x_n - \frac{2}{x_n} \right)$

B. $x_{n+1} = \frac{1}{2} \left(-x_n + \frac{2}{x_n} \right)$

C. $x_{n+1} = -\frac{1}{2} \left(x_n + \frac{2}{x_n} \right)$

D. $x_{n+1} = \frac{1}{2} \left(x_n + \frac{2}{x_n} \right)$

Ans. D

Sol. Let, $x = \sqrt{2}$

Squaring both sides,

$$\Rightarrow x^2 = 2$$

$$\Rightarrow x^2 - 2 = 0$$

Let, $f(x_n) = x_n^2 - 2$

Different with respect to ' x_n '

$$\Rightarrow f'(x_n) = 2x_n$$

By Newton - Raphson method,

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

$$x_{n+1} = x_n - \frac{(x_n^2 - 2)}{2x_n}$$

$$x_{n+1} = \frac{2x_n^2 - x_n^2 + 2}{2x_n} = \frac{x_n^2 + 2}{2x_n}$$

$$x_{n+1} = \frac{1}{2} \left[x_n + \frac{2}{x_n} \right]$$

74. The Gauss-Seidel iterative method for the system of equation

$$-\frac{1}{4}x_2 - \frac{1}{4}x_3 + x_4 = \frac{1}{4}, \quad -\frac{1}{4}x_1 + x_3 - \frac{1}{4}x_4 = \frac{1}{4},$$

$$x_1 - \frac{1}{4}x_2 - \frac{1}{4}x_3 = \frac{1}{2}, \quad -\frac{1}{4}x_1 + x_2 - \frac{1}{4}x_4 = \frac{1}{2}$$

- A. $x_1^{(n+1)} = 0.5 - 0.25x_2^{(n)} + 0.25x_3^{(n)},$
 $x_2^{(n+1)} = 0.5 + 0.25x_1^{(n+1)} + 0.25x_4^{(n)},$
 $x_3^{(n+1)} = 0.25 + 0.25x_1^{(n+1)} + 0.25x_4^{(n)},$
 $x_4^{(n+1)} = 0.25 - 0.25x_2^{(n+1)} + 0.25x_3^{(n+1)},$
- B. $x_1^{(n+1)} = 0.5 + 0.25x_2^{(n)} + 0.25x_3^{(n)},$
 $x_2^{(n+1)} = 0.5 + 0.25x_1^{(n+1)} + 0.25x_4^{(n)},$
 $x_3^{(n+1)} = 0.25 + 0.25x_1^{(n+1)} + 0.25x_4^{(n)},$
 $x_4^{(n+1)} = 0.25 + 0.25x_2^{(n+1)} + 0.25x_3^{(n+1)},$
- C. $x_1^{(n+1)} = 0.5 + 0.25x_2^{(n)} + 0.25x_3^{(n)},$
 $x_2^{(n+1)} = 0.5 + 0.25x_1^{(n+1)} - 0.25x_4^{(n)},$
 $x_3^{(n+1)} = 0.25 + 0.25x_1^{(n+1)} - 0.25x_4^{(n)},$
 $x_4^{(n+1)} = 0.25 + 0.25x_2^{(n+1)} + 0.25x_3^{(n+1)},$
- D. $x_1^{(n+1)} = 0.5 + 0.25x_2^{(n)} - 0.25x_3^{(n)},$
 $x_2^{(n+1)} = 0.5 - 0.25x_1^{(n+1)} + 0.25x_4^{(n)},$
 $x_3^{(n+1)} = 0.25 + 0.25x_1^{(n+1)} + 0.25x_4^{(n)},$
 $x_4^{(n+1)} = 0.25 + 0.25x_2^{(n+1)} + 0.25x_3^{(n+1)},$

Ans. B

Sol. Gauss – Seidal iterative method works on the principle of diagonal dominancy.

According to it, given system of Linear equations can be rearranged as

$$x_1 - \frac{1}{4}x_2 - \frac{1}{4}x_3 = \frac{1}{2} \quad \dots(i)$$

$$-\frac{1}{4}x_1 + x_2 + 0x_3 - \frac{1}{4}x_4 = \frac{1}{2} \quad \dots(ii)$$

$$-\frac{1}{4}x_1 + 0x_2 + x_3 - \frac{1}{4}x_4 = \frac{1}{4} \quad \dots(iii)$$

$$0x_1 - \frac{1}{4}x_2 - \frac{1}{4}x_3 + x_4 = \frac{1}{4} \quad \dots(iv)$$

1. $x_1 = 0.5 + 0.25x_2 + 0.25x_3$
2. $x_2 = 0.5 + 0.25x_1 + 0.25x_4$
3. $x_3 = 0.25 + 0.25x_1 + 0.25x_4$
4. $x_4 = 0.25 + 0.25x_2 + 0.25x_3$

75. What is the missing figure in the following table?

x	1	2	3	4	5
y = f(x)	2	5	7	-	32

- A. 10
- B. 13
- C. 14
- D. 17

Ans. C

Sol. Given data

x	1	2	3	4	5
y = f(x)	2	5	7	-	32

The values of x are called as argument and corresponding values of f(x) or y are called as entries. In the given data arguments (values of x) are equally spaced and y (4) = f(4) is missing entry. To find f (4) we will use,

$$\Delta^r f(x) = 0$$

Where, $\Delta = E - 1$ and $r = 4$ (no. of entries given)

$$(E - 1)^4.f(x) = 0$$

$$(E^2 - 2E + 1)^2.f(x) = 0$$

$$(E^4 + 4E^2 + 1 - 4E^3 - 4E + 2E^2) f(x) = 0$$

$$(E^4 - 4E^3 + 6E^2 - 4E + 1). f(x) = 0$$

Put x = 1

$$E^4 f(1) - 4E^3f(1) + 6E^2f(1) - 4Ef(1) + f(1) = 0$$

$$= f(5) - 4f(4) + 6f(3) - 4f(2) + f(1) = 0$$

$$= 32 - 4f(4) + 6 \times 7 - 4 \times 5 + 2 = 0$$

$$= 32 + 42 - 20 + 2 = 4 f(4)$$

$$= 4f(4) = 56$$

$$= f(4) = 14$$

76. What is $f'(0.2)$ from the following tabular data?

X	0.0	0.2	0.4	0.6	0.8	1.0
f(x)	1.00	1.16	3.56	13.96	41.96	101.00

A. 4.2

B. 2.2

C. 5.2

D. 3.2

Ans. D

Sol. Forward difference Table

x	f(x)	$\Delta f(x)$	$\Delta^2 f(x)$	$\Delta^3 f(x)$	$\Delta^4 f(x)$	$\Delta^5 f(x)$
0	1					
0.2	1.16	0.16				
0.4	3.56	2.4	2.24			
0.6	13.96	10.4	8	5.76		
0.8	41.96	28	17.6	9.6	3.84	
1	101	59.04	31.04	13.44	3.84	0

Here,

$$a = 0.2,$$

$$\Delta^2 f(a) = 8,$$

$$f(a) = 1.16., \Delta f(a) = 2.4$$

$$\Delta^3 f(a) = 9.6, \Delta^4 f(a) = 3.84$$

By Newton's Gregory formula for forward interpolation,

$$f(a + nh) = f(a) + n\Delta f(a) + \frac{n(n-1)}{2!} \Delta^2 f(a) + \frac{n(n-1)(n-2)}{3!} \Delta^3 f(a) + \frac{n(n-1)(n-2)(n-3)}{4!} \Delta^4 f(a) + \dots$$

$$f(a + nh) = f(a) + n\Delta f(a) + \frac{(n^2 - n)}{2!} \Delta^2 f(a) + \frac{(n^3 - 3n^2 + 2n)}{3!} \Delta^3 f(a) + \frac{(n^4 - 6n^3 + 11n^2 - 6n)}{4!} \Delta^4 f(a) + \dots$$

$$hf'(a + nh) = \Delta f(a) + \frac{(2n-1)}{2!} \Delta^2 f(a) + \frac{(3n^2 - 6n + 2)}{3!} \Delta^3 f(a) + \frac{(4n^3 - 18n^2 + 22n - 6)}{4!} \Delta^4 f(a) + \dots$$

.....

Put, n = 0

$$hf'(a) = \Delta f(a) - \frac{1}{2} \Delta^2 f(a) + \frac{1}{3} \Delta^3 f(a) - \frac{1}{4} \Delta^4 f(a) + \dots$$

Put a = 0.2, h = 0.2

$$0.02 f'(0.2) = \Delta f(0.2) - \frac{1}{2} \Delta^2 f(0.2) + \frac{1}{3} \Delta^3 f(0.2) - \frac{1}{4} \Delta^4 f(0.2)$$

$$0.2 f'(0.2) = 2.4 - \frac{1}{2} (8) + \frac{1}{3} (9.6) - \frac{1}{4} (3.84)$$

$$0.2 f'(0.2) = 0.64$$

$$f'(0.2) = 3.2$$

77. Of the five boys A, B, C, D and E two are good, one is poor and two are average in studies. Two of them study in post-graduate classes and three in under graduate classes. One comes from a rich family, two from middle class families and two from poor families. One of them is interested in music, two in acting and one in sports. Of those studying in under graduate classes, two are average and one is poor in studies. Of the two boys interested in acting, one is a post-graduate student. The one who is interested in music comes from a middle class family. Both of the boys interested in acting are not industrious, good in studies, come from middle class families, are average in studies and one of them is interested in acting. The boy interested in sports comes from a poor family, while the one interested in music is industrious. E is industrious, good in studies comes from a poor family and is not interested in acting, music or sports. C is poor in studies in spite of being industrious. A comes from a rich family, is not industrious but good in studies. B is industrious and comes from a middle class family. Name the boy who is not industrious and is average in studies.

- A. A
- B. B
- C. C
- D. D

Ans. D

Sol. E = Ind + Studies (Good) + PF + Acting + Music + Sports

C = Studies (Poor) + Ind

A = RF + Ind + Studies (Good)

B = Ind + MCF

Where,

Ind → industrious

PF → Poor family

PF → Rich family

MCF → Middle class family

E, C, and B are industrious.

A is not industrious but good in studies.

Only remaining option is D.

78. At an electric Data Processing Unit five out of the eight program sets P, Q, R, S, T, U, V and W are to be operated daily. On any one day except for the first day of the month only three of the program sets must be the ones that were operated on the previous day. The program operating must also satisfy the following conditions:

1. If program P is to be operated on a day, V cannot be operated on that day.
2. If Q is to be operated on a day, T must be one of the programs to be operated after Q.
3. If R is to be operated on a day, V must be one of the programs to be operated after R.
4. The last program to be operated on any day must be either S or U.

If the program sets R and W are to be operated on the first day which of the following could be the other programs on that day?

- | | |
|------------|------------|
| A. Q, V, S | B. Q, T, V |
| C. T, S, U | D. T, S, V |

Ans. D

Sol. 1. V cannot be operated on the same day as P.

2. Q and T are in sequence

3. R and V are in sequence

4. Last program = S or U

1st day → R and W are to be operated.

other programs → V (since it is one of the programs to be operated after R)

→ S or U (last program)

above conditions are satisfied by option (a) and (d)

Option (a) → If Q is there, T also will be there. So, total programs become 6.

Option (d) → V, S, T. This is correct.

79. Read the following information carefully and answer the question given below it :

1. Eight doctors P, Q, R, S, T, U, V and W visit a charitable dispensary every day except on a holiday i.e., Monday.
2. Each doctor visits for one hour from Tuesday to Sunday except Saturday. The timings are 9 A.M. to 1 P.M. and 2 P.M. to 6 P.M., 1 P.M. to 2 P.M. is lunch break.
3. On Saturday it is opened only in the morning i.e., 9 A.M. to 1 P.M. and each doctor visits for only half an hour.
4. No other "doctor visits the dispensary before doctor Q and after U.
5. Doctor W comes immediately after the lunch break and is followed by R.
6. S comes in the same order as P in the afternoon session.

If the lunch break and subsequent visiting hours are reduced by 15 minutes, at what time doctor U is expected to attend the dispensary?

- A. 3.15 P.M.
- B. 4 P.M.
- C. 4.15 P.M.
- D. 4.45 P.M.

Ans. B

Sol. Q = 1st

U = Last = 8th Slot

Lunch and slots after lunch are reduced by 15 min.

Timings:

9 A.M. – 1 P.M. → 4 slots

1 P.M. – 1:45 P.M. → Lunch

1:45 P.M. – 2:30 P.M. → 5th slot

2:30 P.M. – 3:15 P.M. → 6th slot

3:15 P.M. – 4:00 P.M. → 7th slot

4:00 P.M. – 4:45 P.M. → 8th slot → U

So, option (b) 4 P.M. is correct.

80. Study the following information carefully and answer the question given below it :

1. P, Q, R, S, T and U are six members in a family in which there are two married couples.
2. T, a teacher, is married to the doctor who is mother of R and U.
3. Q, the lawyer, is married to P.
4. P has one son and one grandson.
5. Of the two married ladies one is housewife.
6. There is one student and one male engineer in the family.

How is R related to U?

- A. Brother only
- B. Sister only
- C. Brother or Sister
- D. Mother

Ans. C

Sol. Q(Lawyer) « P(Housewife)

T(Teacher) « S(Doctor)

R – U

Male Engineer = R or U

Student = R or U

R and U are siblings.

81. Which one of the following methods is used when the non-isometric lines or their ends lie in isometric planes?

- A. Co-ordinate method
- B. Box method
- C. Offset method
- D. Visual-ray method

Ans. B

Sol. Box method: This method is used when the non- isometric lines or their ends lie in isometric planes. The object is assumed to be enclosed in a rectangular box. Initially, the box is drawn in isometric. The ends of the lines for the inclined edges are then located by measuring on or from the outlines of the box.

82. If $X_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$, $X_2 = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$ and $X_3 = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$, are the eigenvectors of the matrix $A = \begin{bmatrix} 2 & 1 & -1 \\ 3 & 2 & -3 \\ 3 & 1 & -2 \end{bmatrix}$, then $A^5 =$

A. $\begin{bmatrix} 32 & 31 & -31 \\ 33 & 32 & -33 \\ 33 & 31 & -32 \end{bmatrix}$

B. $\begin{bmatrix} 32 & 31 & -33 \\ 33 & 32 & -31 \\ 33 & 31 & -32 \end{bmatrix}$

C. $\begin{bmatrix} 32 & 31 & -32 \\ 33 & 32 & -33 \\ 33 & 31 & -31 \end{bmatrix}$

D. $\begin{bmatrix} 32 & 33 & -31 \\ 33 & 32 & -33 \\ 33 & 31 & 32 \end{bmatrix}$

Ans. A

Sol. Checking with option A

$B.X. = \lambda$

$$\begin{bmatrix} 32 & 31 & -31 \\ 33 & 32 & -33 \\ 33 & 31 & -32 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 32 \\ 32 \\ 32 \end{bmatrix} = 32 \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

$$\& \begin{bmatrix} 32 & 31 & -31 \\ 33 & 32 & -33 \\ 33 & 31 & -32 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = 1 \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$$

$$\& \begin{bmatrix} 32 & 31 & -31 \\ 33 & 32 & -33 \\ 33 & 31 & -32 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ -1 \\ -1 \end{bmatrix} = -1 \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$$

$\lambda_1 = 32, \lambda_2 = 1, \lambda_3 = -1$

$\lambda_1 + \lambda_2 + \lambda_3 = 32$

$\& \lambda_1 \cdot \lambda_2 \cdot \lambda_3 = -32 |A|$

83. The equation for the ellipsoid of inertia of a solids body is

$P(x) = 4x_1^2 + 4x_2^2 + x_3^2 - 2x_1x_2.$

What is the standard form in term of a new orthogonal set of axes $O \{y_1, y_2, y_3\}$?

(By word meaning)

A. $y_1^2 - 3y_2^2 + 3y_3^2$

B. $y_1^2 + 5y_2^2 + 3y_3^2$

C. $y_1^2 - 5y_2^2 + 3y_3^2$

D. $y_1^2 + 5y_2^2 - 3y_3^2$

Ans. B

Sol. $\begin{bmatrix} x_1 & x_2 & x_3 \end{bmatrix} \begin{bmatrix} 4 & -1 & 0 \\ -1 & 4 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$

The Characteristic equation.

$$\begin{vmatrix} 4 - \lambda & -1 & 0 \\ -1 & 4 - \lambda & 0 \\ 0 & 0 & 1 - \lambda \end{vmatrix} = 0$$

$(4 - \lambda)[(4 - \lambda)(1 - \lambda)] + [(\lambda - 1)] = 0$

$$(1 - \lambda)[(4 - \lambda)^2 - 1] = 0$$

$$(1 - \lambda)[\lambda^2 - 8\lambda + 15] = 0$$

$$(1 - \lambda)(\lambda - 3)(\lambda - 5) = 0$$

$$\lambda = 1, 3, 5$$

$$1.y_1^2 + 5.y_2^2 + 3y_3^2$$

84. What is the general solution of a homogeneous differential equation with the characteristic equation?

$$\lambda^3(\lambda + 4)^2(\lambda^2 + 2\lambda + 5)^2 = 0$$

$$y(x) = c_1 + c_2x + c_3x^2 + c_4e^{-4x} + c_5xe^{4x} + e^x \{c_6 \cos 2x + c_7 \sin 2x + c_8x \cos 2x + c_9x \sin 2x\}$$

$$y(x) = c_1 + c_2x + c_3x^2 + c_4e^{-4x} + c_5xe^{4x} + e^x \{c_6 \cos 2x + c_7 \sin 2x\} + e^{-x} \{c_8x \cos 2x + c_9x \sin 2x\}$$

$$y(x) = c_1 + c_2x + c_3x^2 + c_4e^{-4x} + c_5xe^{-4x} + e^{-x} \{c_6 \cos 2x + c_7 \sin 2x\} + e^x \{c_8x \cos 2x + c_9x \sin 2x\}$$

$$y(x) = c_1 + c_2x + c_3x^2 + c_4e^{-4x} + c_5xe^{-4x} + e^{-x} \{c_6 \cos 2x + c_7 \sin 2x + c_8x \cos 2x + c_9x \sin 2x\}$$

Ans. B

Sol. Given characteristic eq is

$$\lambda^3(\lambda + 4)^2(\lambda^2 + 2\lambda + 5)^2 = 0$$

$$\lambda_1 = \lambda_2 = \lambda_3 = 0$$

And $\lambda_4 = \lambda_5 = -4$

And $\lambda^2 + 2\lambda + 5 = 0$

$$\lambda = \frac{-2 \pm \sqrt{2^2 - 4 \times 1 \times 5}}{2 \times 1} = \frac{-2 \pm 4i}{2} = -1 \pm 2i$$

$\therefore \lambda_6 = \lambda_7 = -1 \pm 2i$

$\therefore C.S = C.F$

$$Y = (C_1 + C_2x + C_3x^2)e^{0x} + (C_4 + C_5x)e^{-4x} + e^{-x}[(C_6 + C_8x)\cos 2x + (C_7 + C_9x)\sin 2x]$$

85. What is the initial value if $\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 3y = e^{-x}$, with $y(0) = 2, \left(\frac{dy}{dx}\right)_{x=0} = 1$?

A. $y(x) = \left(\frac{13}{4} + \frac{1}{2}x\right)e^{-x} - \frac{5}{4}e^{-3x}$

B. $y(x) = \left(\frac{13}{4} + \frac{1}{2}x\right)e^{-3x} - \frac{5}{4}e^{-x}$

C. $y(x) = \left(\frac{13}{4} + \frac{1}{2}x\right)e^{-x} + \frac{5}{4}e^{-3x}$

D. $y(x) = \left(\frac{13}{4} - \frac{1}{2}x\right)e^{-x} - \frac{5}{4}e^{-3x}$

Ans. A

Sol. $\frac{d^2y}{dx^2} + 4 \cdot \frac{dy}{dx} + 3y = e^{-x}$... (1)

With initial and $y(0) = 2, \left. \frac{dy}{dx} \right|_{x=0} = 1$

Let $\frac{d}{dx} = D$

$\Rightarrow (D^2 + 4D + 3) \cdot y = e^{-x}$

The A.E is,

$f(m) = 0$

$m^2 + 4m + 3 = 0$

$(m + 1)(m + 3) = 0$

$m_1 = -1$ and $m_2 = -3$

roots are real and different,

C.F. = $C_1e^{m_1x} + C_2e^{-m_2x}$

C.F. = $C_1e^{-x} + C_2e^{-3x}$

Now, P.I = $\frac{1}{f(D)} \cdot X$

$P.I = \frac{1}{(D^2 + 4D + 3)} e^{-x}$...Case I (replace D by a : a = -1)

$= \frac{1}{(-1)^2 + 4(-1) + 3} e^{-x}$

$= \frac{1}{0} e^{-x}$

Case I fails

$P.I = x \cdot \frac{1}{(2D + 4)} e^{-x}$

$P.I = x \cdot \frac{1}{2(-1) + 4} e^{-x}$

$P.I = \frac{x}{2} e^{-x}$

Now, C.S. = C.F. + P.I.

$y = C_1e^{-x} + C_2e^{-3x} + \frac{x}{2} e^{-x}$... (2)

Puts $y(0) = 2$ in (3)

$\Rightarrow 2 = C_1 + C_2 + 0$

$C_1 + C_2 = 2$... (3)

Now, diff equation (2)

$\Rightarrow \frac{dy}{dx} = -C_1e^{-x} - 3C_2e^{-3x} + \frac{x}{2} e^{-x}(-1) + \frac{e^{-x}}{2}$

Put $\frac{dy}{dx} = 1$ at $x = 0$

$\Rightarrow 1 = -C_1 - 3C_2 + 0 + \frac{1}{2}$

$C_1 + 3C_2 = -\frac{1}{2}$... (4)

Solving 3 and 4

$$2C_2 = -\frac{1}{2} - 2 \Rightarrow C_2 = -\frac{5}{4}$$

$$\text{And } C_1 = 2 + \frac{5}{4} = \frac{13}{4}$$

$$2 \text{ } \therefore y = \frac{13}{4}e^{-x} - \frac{5}{4}e^{-3x} + \frac{x}{2}e^{-x}$$

$$y = \left(\frac{13}{4} + \frac{x}{2}\right)e^{-x} - \frac{5}{4}e^{-x}$$

86. $\mathcal{L}\{f(t)\} = \frac{e^{-3s}(1-2s)}{2s^2-s+1}$, then $\mathcal{L}\{f(3t)\} =$

A. $\frac{e^{-s}(-3-2s)}{2s^2-3s+9}$

B. $\frac{e^{-s}(3+2s)}{2s^2-3s+9}$

C. $\frac{e^{-s}(3-s)}{2s^2-3s+9}$

D. $\frac{e^{-s}(3-2s)}{2s^2-3s+9}$

Ans. D

Sol. Given,

$$L\{f(t)\} = F(s) = \frac{e^{-3s}(1-2s)}{2s^2-s+1}$$

By change of scale Property,

If $L\{f(t)\} = F(s)$

$$\text{Then, } L\{f(at)\} = \frac{1}{a}F\left(\frac{s}{a}\right)$$

$$\text{Now, } L\{f(3t)\} = \frac{1}{3}F\left(\frac{s}{3}\right)$$

$$= \frac{1}{3} \frac{e^{-3\left(\frac{s}{3}\right)}\left(1-2\left(\frac{s}{3}\right)\right)}{2\left(\frac{s}{3}\right)^2 - \left(\frac{s}{3}\right) + 1}$$

$$= \frac{1}{3} \frac{e^{-s}(3-2s)/3}{(2s^2-3s+9)/9}$$

$$= \frac{e^{-s}(3-2s)}{(2s^2-3s+9)}$$

87. What is the solution of the equation $\frac{d^2y}{dt^2} + y(t) = \int_0^t \sin \tau y(t-\tau) d\tau$ subject to the initial conditions

$$y(0) = 1 \text{ and } \left(\frac{dy}{dt}\right)_{t=0} = 0?$$

A. $y(t) = \frac{1}{2}(1 - \cos \sqrt{2}t)$, for $t > 0$

B. $y(t) = \frac{1}{2}(1 + \cos \sqrt{2}t)$, for $t > 0$

C. $y(t) = \frac{1}{2}(-1 - \cos \sqrt{2}t)$, for $t > 0$

D. $y(t) = -\frac{1}{2}(1 - \cos \sqrt{2}t)$, for $t > 0$

Ans. B

Sol. $y''(t) + y(t) = \int_0^t \sin \tau \cdot y(t - \tau) d\tau$

$y(0) = 1$ and $y'(0) = 0$

$[s^2 y(s) - sy(0) - y'(0)] + y(s) = \frac{1}{s^2 + 1} y(s)$

$\left(s^2 + 1 - \frac{1}{s^2 + 1}\right) y(s) = sy(0) + y'(0) = s + 0$

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

$y(s) = \frac{s(s^2 + 1)}{(s^2 + 1)^2 - 1}$

$y(s) = \frac{s(s^2 + 1)}{s^4 + 2s^2}$

$= \frac{s(s^2 + 1)}{s^2(s^2 + 2)}$

$= \frac{(s^2 + 1)}{s(s^2 + 2)} = \frac{(s^2 + 2)}{s(s^2 + 2)} - \frac{1}{s(s^2 + 2)}$

$= \frac{1}{s} - \frac{1}{2} \left[\frac{1}{s} - \frac{s}{s^2 + 2} \right]$

$y(t) = 1 - \frac{1}{2} [1 - \cos \sqrt{2}t], t > 0$

$y(t) = \frac{1}{2} [1 + \cos \sqrt{2}t], t > 0$

88. The n th coefficient of a series is given by $a_n = \frac{1 \cdot 5 \cdot 9 \cdot 13 \dots (4n+1)}{2^n}$. What is the expression a_n in terms of the gamma function?

A. $a_n = 2^{n+2} \frac{\Gamma\left(n + \frac{5}{4}\right)}{\Gamma\left(\frac{1}{4}\right)}$

B. $a_n = 2^{n+1} \frac{\Gamma\left(n + \frac{5}{4}\right)}{\Gamma\left(\frac{1}{4}\right)}$

C. $a_n = 2^n \frac{\Gamma\left(n + \frac{5}{4}\right)}{\Gamma\left(\frac{1}{4}\right)}$

D. $a_n = 2^{n+3} \frac{\Gamma\left(n + \frac{5}{4}\right)}{\Gamma\left(\frac{1}{4}\right)}$

Ans. A

Sol. $a_n = \frac{1.5.9.13.....(4n+1)}{2^n}$

For n = 2

$$a_2 = \frac{1.5.9}{2^2} = \frac{45}{4}$$

Option a $a_n = 2^{n+2} \sqrt[n]{\frac{n + \frac{5}{4}}{\frac{1}{4}}}$

n = 2 $a_n = a_2 = 2^4 \sqrt[2]{\frac{2 + \frac{5}{4}}{\frac{1}{4}}}$

$$= 16 \sqrt[2]{\frac{\frac{13}{4}}{\frac{1}{4}}}$$

$$= 16 \sqrt[2]{\frac{\frac{9}{4} \cdot \frac{5}{4} \cdot \frac{1}{4} \cdot \frac{1}{4}}{\frac{1}{4}}}$$

$$= \frac{45}{4}$$

89. Fourier series representation of $f(x) = x + 1$ for $-1 \leq x \leq 1$ is

A. $f(x) = 1 - \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} \sin n\pi x$

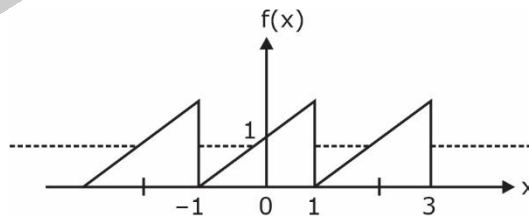
B. $f(x) = -1 - \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} \sin n\pi x$

C. $f(x) = 1 + \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} \sin n\pi x$

D. $f(x) = -1 + \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} \sin n\pi x$

Ans. C

Sol. $f(x) = x + 1 : -1 \leq x \leq 1$



$T=2$

$$a_0 = \frac{1}{T} \int_{-T/2}^{T/2} f(x) \cdot \sin(2n\pi f_0 x) dx$$

$$f_0 = \frac{1}{T} = \frac{1}{2}$$

$$= \left[(x+1) \left\{ \frac{-\cos(n\pi x)}{n\pi} \right\} - 1 \left\{ \frac{-\sin(n\pi x)}{n^2 \pi^2} \right\} \right]_{-1}^1$$

$$= \left[\frac{-2}{n\pi} (-1)^n + 0 \right] - [0 + 0]$$

$$b_n = \frac{-2}{n\pi} (-1)^n$$

$$a_n = \frac{2}{T} \int_{-T/2}^{T/2} f(x) \cos(2n\pi f_0 x) dx$$

$$= \frac{2}{2} \int_{-1}^1 (x+1) \cos(n\pi x) dx$$

$$= \left[(x+1) \frac{\sin(n\pi x)}{n\pi} - 1 \left(\frac{-\cos n\pi x}{n^2 \pi^2} \right) \right]_{-1}^1$$

$$\boxed{a_n = 0}$$

∴ Fourier series is given by,

$$f(x) = a_0 + \sum_{n=1}^{\infty} b_n \sin(2n\pi f_0 x)$$

$$f(x) = 1 - \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^n}{n} \sin(n\pi x)$$

$$f(x) = 1 + \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} \sin(n\pi x)$$

90. Let $f(x) = \begin{cases} 1, & |x| < a \\ 0, & |x| > a \end{cases}$ and $g(x) = \begin{cases} 1, & 0 < x < a \\ 0, & \text{otherwise} \end{cases}$ then the Fourier transform of $3f(x) - 2g(x)$ is

A. $\sqrt{\frac{2}{\pi}} \left\{ \frac{3 \sin \omega a}{\omega} + \left(\frac{1 - e^{-i\omega a}}{i\omega} \right) \right\}$

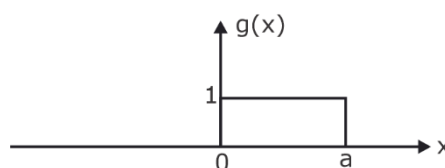
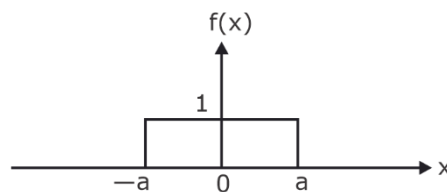
B. $\sqrt{\frac{2}{\pi}} \left\{ \frac{3 \sin \omega a}{\omega} - \left(\frac{1 + e^{-i\omega a}}{i\omega} \right) \right\}$

C. $\sqrt{\frac{2}{\pi}} \left\{ \frac{-3 \sin \omega a}{\omega} - \left(\frac{1 - e^{-i\omega a}}{i\omega} \right) \right\}$

D. $\sqrt{\frac{2}{\pi}} \left\{ \frac{3 \sin \omega a}{\omega} - \left(\frac{1 - e^{-i\omega a}}{i\omega} \right) \right\}$

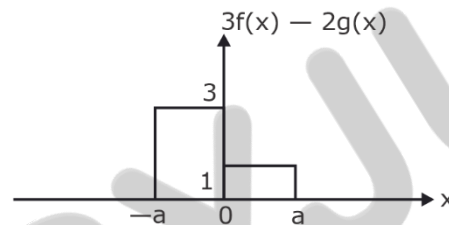
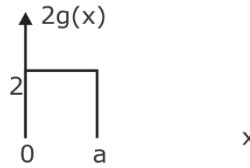
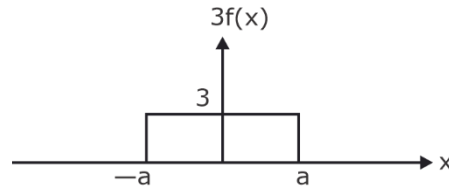
Ans. *

Sol.



$$f(x) \begin{cases} 1; & |x| < a \\ 0; & |x| > a \end{cases}$$

$$g(x) \begin{cases} 1; & 0 < x < a \\ 0; & \text{o.w.} \end{cases}$$



$$f\{3f(x) - 2g(x)\}$$

$$= \int_{-a}^0 3e^{-jwx} \cdot dx + \int_0^a 1e^{-jwx} \cdot dx$$

$$= 3 \left[\frac{e^{-jwx}}{-jw} \right]_{-a}^0 + \left[\frac{e^{-jwx}}{-jw} \right]_0^a$$

$$= \frac{3}{-jw} [1 - e^{jwa}] + \frac{1}{-jw} [e^{-jwa} - 1]$$

$$= \frac{-1}{jw} [3 - 3e^{jwa} + e^{-jwa} - 1]$$

$$= \frac{1}{jw} [3e^{jwa} - e^{-jwa} - 2]$$

$$= \frac{1}{jw} [3(e^{jwa} - e^{-jwa}) + 2e^{-jwa} - 2]$$

$$= \frac{2 \times 3}{w} \left(\frac{e^{jwa} - e^{-jwa}}{2j} \right) + \frac{2}{jw} (e^{-jwa} - 1)$$

$$= \frac{6}{w} \sin aw + \frac{2}{jw} (e^{-jwa} - 1)$$

91. Read the following information carefully and answer the question that follow:

1. Madhu and Shobha are good in Dramatics and Computer Science.
2. Anjali and Madhu are good in Computer Science and Physics.
3. Anjali, Poonam and Nisha are good in Physics and History.
4. Nisha and Anjali are good in Physics and Mathematics.

5. Poonam and Shobha are good in History and Dramatics. Who is good in History, Physics, Computer Science and Mathematics?

- A. Poonam
- B. Nisha
- C. Madhu
- D. Anjali

Ans. D

Sol. Madhu - Dramatics, Computer science, Physics,
Shobha - Dramatics, Computer science, History
Anjali – Computer science, Physics, History, Mathematics
Poonam - Physics, History, Dramatics
Nisha - Physics, History, Mathematics
Ans - Anjali
Option (D) is correct.

92. The question given below has three statements followed by three conclusions numbered I, II and III. You have to take the given statements to be true even if they seem to be at variance from commonly known facts. Read all the conclusions and then decide which of the given conclusions logically follows from the given statements disregarding commonly known facts.

Statements:

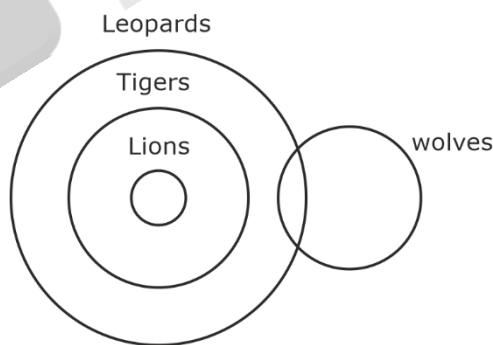
- All lions are tigers.
- All tigers are leopards.
- Some leopards are wolves.

Conclusions:

- I. No elephant is lion.
 - II. Some wolves are lions.
 - III. Some leopards are lions.
- A. Only I follows
 - B. Only II follows
 - C. Only III follows
 - D. Only I and III follows

Ans. C

Sol.



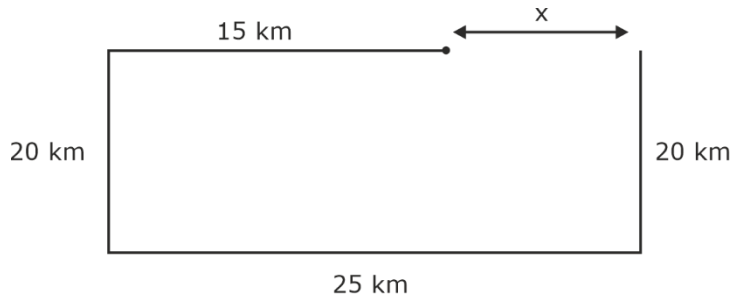
Conclusion III follows

93. Rohith went 15 km to the west from his house, then he turned left and walked 20 km. He then turned east and walked 25 km and finally turning left covered 20 km. How 'far is he from his house?

- A. 5 km
- B. 10 km
- C. 40 km
- D. 80 km

Ans. B

Sol.



$$x = 25 - 15 = 10 \text{ km}$$

94. Cryptic language is popular since ages, mostly in the field of espionage and sending classified messages. If 'I LOVE YOU' is coded as 7, then how would you code 'GO TO HELL' in the same language?

- A. 1
- B. 4
- C. 3
- D. 6

Ans. B

Sol.

L = 9	G → 7
L = 12	O → 15
O = 15	T → 20
V = 22	O → 15
E = 5	H → 8
Y = 25	E → 5
O = 15	L → 12
U = 21	L → 12
Sum 124 = 1 + 2 + 4 = 7	94 = 9+4=13 = 1+3 = 4

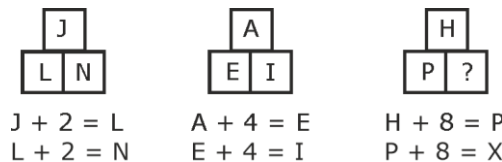
95. What letter should replace the question mark?



- A. Z
- B. Y
- C. X
- D. Z

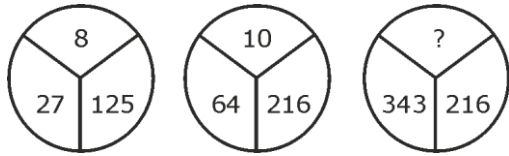
Ans. C

Sol.



X is the missing letter.
∴ Option C is correct.

96. In the first two circles, the number inside the circle is written according to a particular relation. What is the number inside the third circle which follows the same relation as that of the first two circles?



- A. 12
- C. 9

- B. 13
- D. 14

Ans. B

- Sol.** $3^3 = 27$
 $5^3 = 125$
 $5 + 3 = 8$
 $4^3 = 64$
 $6^3 = 216$
 $6 + 4 = 10$
 $7^3 = 343$
 $6^3 = 216$
 $7 + 6 = 13$

97. Deepthi is playing a treasure hunt game. At the first stage, Deepthi needs to choose a five digit code to unlock the vault which contains the treasure. She gets the following codes to choose from

- | | | |
|-------|-------|-------|
| 15342 | 26540 | 35412 |
| 23105 | 15320 | 13402 |
| 35047 | 71024 | 28305 |

The following clues are given to her help to find the code.

- P. The code number is not an even number.
- Q. The product of the first two digits number.
- R. The sum of the first four digits is 12.
- S. The code number is not a multiple of 5.

If Deepthi had the option of selecting only due clue, which of the four clues will gives her the best chance of finding out the five digit code?

- A. S
- B. R
- C. Q
- D. P

Ans. B

Sol.

	P	Q	R	S
15342		Right		Right
23105	Right			
35047	Right	Right	Right	Right
26540				
15320		Right		
71024		Right		Right
35412		Right		Right
13402		Right		Right
28305	Right			

- 98.** Suppose you enter an elevator at a certain floor. Then the elevator moves up 5 floors, down 3 floors, and up 2 floors. If you are then at the 8th floor, on what floor did you first enter the elevator?
- A. 8
B. 7
C. 6
D. 9

Ans. *

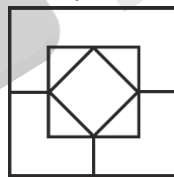
Sol. Consider you are in 'x' floor
Elevator moves 5 floor up, therefore the current position = $x + 5$
Then elevator moves 3 floor down
Current position = $x + 5 - 3$
Further the elevator moves 2 floors up
Current position = $x + 5 - 3 + 2$
 $x + 5 - 3 + 2 = 8$
 $x = 4$

- 99.** A number series is given with one term missing. Choose the correct alternative from the options.
0.5 m 0.55, 0.65, 0.8, ?
- A. 0.9
B. 0.95
C. 0.82
D. 1

Ans. D

Sol. 0.5 0.55 0.65 0.8 ?
 $0.5 + 0.05 \rightarrow 0.55$
 $0.55 + 0.1 \rightarrow 0.65$
 $0.65 + 0.15 \rightarrow 0.8$
 $0.8 + 0.2 \rightarrow 1$

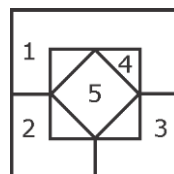
- 100.** The soccer club is putting together a mural using lightly colored transparent paper. This paper then is cut into squares of different sizes that are placed next to each other to make the designs for the mural. Of course, the club wants to save money, so its members are trying to buy the minimum number of sheets 'of colored paper. Below is one of the designs they are going to use. What is the minimum number of squares they will need to make this design?



- A. 4
B. 5
C. 6
D. 7

Ans. B

Sol.



1. 1 Big Square
2. 2 Folded squares at the bottom
3. 1 square at the centre
4. 1 titled square at the centre

Answer Key

SET-B							
Q. No.		Q.No.		Q.No.		Q.No.	
1.	A	26.	B	51.	C	76.	D
2.	D	27.	C	52.	D	77.	D
3.	C	28.	B	53.	A	78.	D
4.	D	29.	C	54.	C	79.	B
5.	A	30.	A	55.	C	80.	C
6.	B	31.	B	56.	D	81.	B
7.	C	32.	A	57.	A	82.	A
8.	D	33.	D	58.	A	83.	B
9.	C	34.	*	59.	B	84.	B
10.	D	35.	A	60.	B	85.	A
11.	A	36.	A	61.	D	86.	D
12.	D	37.	C	62.	D	87.	B
13.	A	38.	B	63.	A	88.	A
14.	A	39.	A	64.	C	89.	C
15.	B	40.	C	65.	B	90.	*
16.	C	41.	C	66.	A	91.	D
17.	B	42.	A	67.	B	92.	C
18.	D	43.	B	68.	A	93.	B
19.	B	44.	A	69.	A	94.	C
20.	D	45.	B	70.	A	95.	C
21.	D	46.	A	71.	A	96.	B
22.	D	47.	D	72.	*	97.	B
23.	B	48.	D	73.	D	98.	*
24.	A	49.	D	74.	B	99.	D
25.	*	50.	B	75.	C	100.	B

Our Outstanding GATE Results



Rank 02
Poojasree (EC)



2021



Rank 03
Manoj (EC)



Rank 03
Munish (ME)



Rank 06
Parag (EC)



Rank 07
Vatsal (ME)



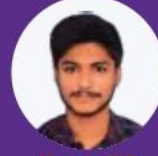
Rank 08
Rahul (CE)



Rank 08
Hemant (EE)



Rank 08
Rajat (ME)



Rank 09
Vamsi (EC)



Rank 13
Shashwat (CE)



Rank 06
Ghanendra (EC)



2020



Rank 09
Avinash (ME)



Rank 09
Himanshu (EE)



Rank 26
Kartikay (CE)



Rank 30
Raja (EC)



Rank 39
Akash Singh (CS)



Rank 39
Navneet (CS)



Rank 54
Rishi (EE)



Rank 56
Apurv Mittal (ME)



Rank 56
Nikhil (ME)

Our Outstanding GATE Results

80+

Students under
AIR-100

2022



Rank 01
Ram (EC)



Rank 02
Amit (CE)



Rank 02
Vandit (EE)



Rank 03
Parvinder (ME)



Rank 06
Abhishek (ME)



Rank 06
Vivek (CE)



Rank 08
Kiran (CS)



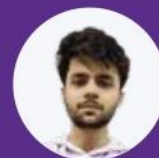
Rank 09
Shivam (EC)



Rank 09
Tushar (EE)



Rank 10
Mitesh (CS)



Rank 11
Kaustav (ME)



Rank 11
Souvik (ME)



Rank 12
Himanshu (CE)



Rank 15
Surya (CS)



Rank 18
Swastik (CE)



Rank 20
Lakshay (ME)



Rank 21
Tathagata (CS)



Rank 22
Ayush (CE)



Rank 29
Piyush (EE)



Rank 38
Rajat (EE)

Prepare with us & get placed in your dream college, PSU or department!

PSUs

ONGC

IOCL

PowerGrid

NTPC

Top Colleges

IISc Bangalore

IIT Madras

IIT Bombay

IIT Kharagpur

Departments through ESE

CPWD

Ministry of Power

Defence Services

Ordnance Services



Website: www.byjusexamprep.com

Address: Windsor IT Park, Tower - A, 2nd Floor,
Sector 125, Noida, Uttar Pradesh 201303

Name:

Contact no:

Email id:

Download The App

