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ESE 2025 : Prelims Exam | GS & ENGINEERING CLASSROOM TEST SERIES | APTITUDE

Test 21

ANUBHAV - PAPER-I

Simulate Real ESE Prelims Exam

Full Syllabus Test

ANSWER KEY

| | | | | |
|---------|---------|---------|---------|----------|
| 1. (b) | 21. (c) | 41. (b) | 61. (a) | 81. (b) |
| 2. (d) | 22. (d) | 42. (d) | 62. (d) | 82. (b) |
| 3. (b) | 23. (c) | 43. (b) | 63. (d) | 83. (c) |
| 4. (d) | 24. (b) | 44. (d) | 64. (b) | 84. (d) |
| 5. (b) | 25. (d) | 45. (c) | 65. (d) | 85. (c) |
| 6. (a) | 26. (a) | 46. (b) | 66. (d) | 86. (c) |
| 7. (d) | 27. (b) | 47. (c) | 67. (a) | 87. (b) |
| 8. (b) | 28. (b) | 48. (b) | 68. (c) | 88. (c) |
| 9. (c) | 29. (b) | 49. (c) | 69. (c) | 89. (d) |
| 10. (c) | 30. (b) | 50. (d) | 70. (b) | 90. (c) |
| 11. (a) | 31. (b) | 51. (b) | 71. (b) | 91. (b) |
| 12. (c) | 32. (c) | 52. (b) | 72. (a) | 92. (a) |
| 13. (c) | 33. (c) | 53. (d) | 73. (d) | 93. (c) |
| 14. (d) | 34. (a) | 54. (d) | 74. (b) | 94. (d) |
| 15. (a) | 35. (a) | 55. (a) | 75. (a) | 95. (a) |
| 16. (c) | 36. (d) | 56. (b) | 76. (a) | 96. (d) |
| 17. (b) | 37. (a) | 57. (a) | 77. (c) | 97. (d) |
| 18. (a) | 38. (b) | 58. (c) | 78. (c) | 98. (d) |
| 19. (b) | 39. (a) | 59. (b) | 79. (b) | 99. (a) |
| 20. (d) | 40. (c) | 60. (d) | 80. (d) | 100. (a) |

1. (b)
Global Alliance Against Hunger and Poverty is an initiative of the G-20 group of countries. This initiative was championed by Brazil during its G20 presidency in 2024, to dramatically expedite efforts to achieve the eradication of poverty and hunger by 2030 as well as to reduce inequalities.
2. (d)
 - G4 Nations includes Brazil, Germany, India, and Japan.
 - The G4 nations support each other's bids for permanent seats in the United Nations Security Council.
 - Group has proposed that Council's membership shall be increased from 15 to 25-26, by adding six permanent and four or five non-permanent members.
3. (b)
The Indian Coast Guard (ICG) launched two Fast Patrol Vessels (FPVs) 'Adamyra' and 'Akshar', marking a milestone in its commitment to enhanced maritime security and indigenous manufacturing.
4. (d)
 - The United Kingdom has officially become the 12th member of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP).
 - CPTPP, initially abbreviated as TPP-11, is a trade agreement that evolved from the Trans-Pacific Partnership. It evolved from the Trans-Pacific Partnership (TPP), which was initially negotiated in 2010.
 - Presently, CPTPP is a trade agreement between 12 countries. In addition to the U.K., the pact currently comprises 11 other countries: Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, and Vietnam.
 - US President Donald Trump pulled the U.S. out of the agreement in 2017.
5. (b)
 - The Human Development Index (HDI) is a composite statistical measure used to assess and rank countries based on their social and economic development.
 - HDI was introduced by the United Nations Development Programme (UNDP) in 1990 as an alternative to purely economic measures like GDP (Gross Domestic Product) per capita.
 - The Human Development Index (HDI) is a key component of the Human Development Report (HDR), which is published annually by the United Nations Development Programme (UNDP).
6. (a)
7. (d)
GSLV-F14 placed INSAT-3DS into the intended geosynchronous transfer orbit and then to a Geo-stationary Orbit.
8. (b)
Best way to create trustworthiness is to act with trustfulness.

9. (c)
- Professional responsibility in engineering prioritizes public health, safety, and welfare as paramount.
 - Blind obedience, cost-cutting, or confidentiality cannot ethically override threats to public well-being.
10. (c)
- Concealing a known safety flaw breaches the principle of honesty, which is central to public trust and professional integrity in engineering.
11. (a)
12. (c)
- While law sets minimum standards enforceable by the state, ethics often demand higher moral conduct, such as honesty, fairness, and concern for public welfare, which may not be codified in law.
 - For instance, disclosing a non-regulated but potential hazard may be ethically required, even if not legally mandated.
13. (c)
14. (d)
15. (a)
- The pioneer species are those species which initiate the development of an ecological community in an area with currently no life form's existence. In primary succession on rocks these are usually lichens which are able to secrete acids to dissolve rock, helping in weathering and soil formation.
 - Pioneer species can tolerate and trade through most of the prevailing harsh environmental conditions.
 - In a climax community, the plants and animals are in balance with each other and their environment. A climax community refers to a stable ecosystem in its final stage of ecological succession. The climax community remains stable as long as the environment remains unchanged.
16. (c)
17. (b)
- The National Tiger Conservation Authority (NTCA) is a statutory body under the Ministry of Environment, Forests, and Climate Change constituted under enabling provisions of the Wildlife (Protection) Act, 1972, as amended in 2006, for strengthening tiger conservation, as per powers and functions assigned to it under the said Act.
 - Union Minister for Environment, Forests and Climate Change acts as chairperson of NTCA.
 - Madhya Pradesh has the most tiger reserves, with six in total. It also has the largest number of tigers in the entire country.

18. (a)
Biological magnification is the phenomenon through which certain pollutants get accumulated in tissues in increasing concentrations along the food chain. Such pollutants (e.g., DDT and PCB) are non-biodegradable i.e., once they are absorbed by an organism, they cannot be metabolised and broken down or excreted out.
19. (b)
Abiotic components are non-living parts of an ecosystem that shape its environment.
20. (d)
In ecology, a habitat means either the area and resources used by a particular species (the habitat of a species) or an assemblage of animals and plants together with their abiotic environment.
21. (c)
22. (d)
 - Fuel cells are highly efficient power-generating systems that produce electricity by combining fuel (hydrogen) and oxygen in an electrochemical reaction.
 - Fuel cells are electrochemical devices that convert the chemical energy of a fuel directly and very efficiently into electricity (DC) and heat, thus doing away with combustion.
 - Though rapid progress has been made; high initial cost is still the biggest hurdle in the widespread commercialization of fuel cells.
23. (c)
24. (b)
Western Ghats (7,953.15 square km) is the largest Natural World Heritage Site in India and Sundarban is the second largest Natural World Heritage Site (1,330.10 square km).
25. (d)
 - Blockchain is a decentralized ledger technology (DLT) that allows secure and transparent transactions without the need for a central authority.
 - Every participant in the blockchain network (node) keeps a copy of the entire blockchain, which ensures transparency and the immutability of the record.
 - Blockchain uses cryptographic hashing, and the consensus mechanisms like Proof of Work (PoW) or Proof of Stake (PoS) ensure that the data cannot be altered without the network's agreement.
26. (a)
 - On-demand self-service is a fundamental feature of cloud computing, where users can provision and manage computing resources as needed without human intervention from the service provider.
 - Resource pooling and multi-tenancy allow cloud providers to serve multiple customers using shared resources while ensuring isolation and security.

- Cloud computing can have robust data security mechanisms, including encryption, authentication, and access control, so the statement about the lack of data security is incorrect.
- Scalability and elasticity are key features of cloud computing, allowing users to scale resources up or down depending on demand.

27. (b)

- Internet of Things (IoT) enables the collection of real-time data from connected devices, which can be analyzed to improve decision-making and overall efficiency.
- IoT allows for automation by enabling devices to communicate with each other and take actions without human intervention, improving efficiency and convenience.
- The increased energy consumption due to constant device connectivity is a disadvantage or challenge and not a benefit of the IoT.

28. (b)

BCC (Blind Carbon Copy) keeps recipients' email addresses private, while CC (Carbon Copy) displays the e-mail addresses of the recipient to everyone the e-mail is sent to.

29. (b)

- AI is the field of computer science that aims to create systems capable of performing tasks that require human intelligence, such as reasoning, learning, and problem-solving.
- AI algorithms are designed to work in both structured (e.g., traditional databases) and unstructured environments (e.g., natural language or image data), depending on the specific application.
- AI technologies include Natural Language Processing (NLP), which helps machines understand and process human language; Robotics, which involves creating intelligent robots; and Expert Systems, which mimic human decision-making.

30. (b)

An advanced persistent threat (APT) is a prolonged and targeted cyber attack in which an intruder gains access to a network and remains undetected for an extended period. APT attacks are initiated to steal highly sensitive data rather than cause damage to the target organization's network. The goal of most APT attacks is to achieve and maintain ongoing access to the targeted network rather than to get in and out as quickly as possible.

31. (b)

- Hypertext Transfer Protocol Secure (HTTPS) is the secure version of HTTP, and it uses encryption protocols like SSL/TLS to secure communication over the internet.
- File Transfer Protocol (FTP) is not inherently secure. Its standard version transmits data in plaintext and is vulnerable to eavesdropping. However, secure versions like SFTP (SSH File Transfer Protocol) exist which provide secure data transfer.
- Secure Shell (SSH) is a cryptographic network protocol used for securely accessing and managing remote servers over an unsecured network.
- Simple Mail Transfer Protocol (SMTP) is used for sending emails but does not provide secure communication by itself. However, secure versions like SMTPS and STARTTLS can be used for secure email transmission.

32. (c)

- The ability of a buildings design to contain fire once started is critical to the protection of the property. The life of the occupants, and also to the surrounding people and buildings is called fire containment.
- Structural protection is a passive fire containment measure that focuses on ensuring the integrity of buildings load bearing elements during a fire, these includes columns, load bearing walls, floors etc.

33. (c)

$$\text{Probability of leak} = 0.0004 \text{ per hour}$$

$$\text{Probability of leaks per year} = 0.0004 \times 24 \times 365 = 3.504$$

Each leak leads to fire with a probability of 0.25

$$\text{Probability of fire per year} = 3.504 \times 0.25 = 0.876$$

$$\begin{aligned} \text{Risk} &= \text{Expected frequency} \times \text{Severity} \\ &= 0.876 \times 9 = 7.884 \end{aligned}$$

34. (a)

| Criteria | Weight | Alt B | Alt C | Alt D |
|-------------|--------|-------------------|--------------------|--------------------|
| Cost | 3 | $+1 \times 3 = 3$ | $0 \times 3 = 0$ | $-1 \times 3 = -3$ |
| Durability | 2 | $0 \times 2 = 0$ | $+1 \times 2 = 2$ | $+1 \times 2 = 2$ |
| Ease of use | 1 | $+1 \times 1 = 1$ | $0 \times 1 = 0$ | $0 \times 1 = 0$ |
| Maintenance | 2 | $+1 \times 2 = 2$ | $-1 \times 2 = -2$ | $0 \times 2 = 0$ |
| Total score | | 6 | 0 | -1 |

Alternative B has highest net score (+6)

So, option (a) is correct.

35. (a)

This is a property of a tetrahedron that when a base edge of a tetrahedron is perpendicular to VP, one slant edge will be parallel to VP.

36. (d)

@30L45 means : a line 30 units long at an angle of 45° from the starting point.

$$\text{Start point} = (10, 20)$$

To find point B, $\Delta x = 30 \cos 45^\circ = \frac{30}{\sqrt{2}} = 21.21$

$$\Delta y = 30 \sin 45^\circ = \frac{30}{\sqrt{2}} = 21.21$$

So, $x_B = 10 + 21.21 = 31.21$
 $y_B = 20 + 21.21 = 41.21$

37. (a)

- Triangulation method : This method is used for developing transition pieces.
- In the development of the lateral surfaces, the starting and closing edges should be the same to obtain the closed object.

- Parallel line method is used for development of cubes, prism and cylinders.
- Radial line method is used for the development of pyramids and cones.

38. (b)

Some important observations regarding section of solids:

1. When a polyhedra is cut by a section plane the section surface boundary is made up of straight lines.
2. When cutting plane passes through midpoint of six sides of cube then section produced is a regular hexagon.
3. When a right prism is cut parallel to axis the section surface produced is a rectangle.
4. When a cylinder is cut parallel to axis section produced is a rectangle with one side equal to height of cylinder and length of other side depends on distance of cutting plane from axis.
5. When cutting plane is parallel to one of the generators of cone then true shape of section is a parabola.
6. When cutting plane cuts a right cone perpendicular to axis then true shape of section is a circle.
7. When inclination of cutting plane with axis of right cone is more than inclination of generator with axis then conic section produced is an ellipse.
8. When inclination of cutting plane with axis of right cone is less than inclination of generator with the axis then section produced is a hyperbola.
9. When inclination of cutting plane with axis is less than inclination of generator with axis and cutting plane passes through apex then section produced is a triangle.
10. When tetrahedron is sectioned such that cutting plane passes through mid point of four sides then section produced is a square.

39. (a)

Given :

$$\begin{aligned}
 P_i &= P_1 = P_2 = P_3 = P_4 = 0.6 \\
 \text{System reliability} &= R_s(t) = 1 - F(t) \\
 &= 1 - (1 - P_1)(1 - P_2)(1 - P_3)(1 - P_4) \\
 &= 1 - (0.4)(0.4)(0.4)(0.4) \\
 &= 0.9744
 \end{aligned}$$

Therefore, Improvement factor = $\frac{0.9744}{0.6} = 1.624$

40. (c)

Average fraction defective, $\bar{p} = \frac{2}{10} = 0.2$

$$n\bar{p} = 10 \times 0.2 = 2$$

$$\begin{aligned}
 \text{UCL} &= n\bar{p} + 3\sqrt{n\bar{p}(1-\bar{p})} \\
 &= 2 + 3\sqrt{2(1-0.2)} = 5.8
 \end{aligned}$$

41. (b)

| Kaizen | Kairyo |
|--|---|
| 1. Kaizen is for small improvement. | Kairyo is for large size technological upgrade. |
| 2. Kaizen is carried on a continual basis. | The change is abrupt in kairyo. It is innovative breakthrough. |
| 3. Kaizen involves little or no investment. | Kairyo involves large investment. |
| 4. Kaizen is continuous and incremental. | Kairyo is intermittent and non- incremental. |
| 5. The effect of Kaizen is long-lasting. | The effect of Kairyo is dramatic. |
| 6. Kaizen appears in small steps. | Kairyo appears in big steps. |
| 7. Kaizen involves all people. | In Kairyo, only selected few individuals are involved. |
| 8. Maintenance and improvement of existing facilities are ensured in Kaizen. | Kairyo emphasises "Scrap and Rebuild" |
| 9. Kaizen encourages collective approach group efforts. | "Individualism", individual ideas are associated with Kairyo. |
| 10. Kaizen signifies conventional knowledge. | Kairyo calls for <ul style="list-style-type: none"> • Technological breakthrough • New research and invention • New management system. |
| 11. Kaizen is people oriented. | Kairyo is technology oriented. |
| 12. The main criterion for Kaizen is process and effort for better results. | The main criterion for Kairyo is increasing profit. |
| 13. Kaizen is suited for slow growth economy. | Kairyo is better suited for fast growth economy. |

42. (d)

- Six sigma is heavily influenced by TQM and zero defect principles.
- Six sigma is not about establishing a separate quality tower within a company or organisation and is also not about cost avoidance. The idea behind six sigma is that if you can measure how many 'defects' you have in a process you can systematically figure out how to eliminate them and get close to 'zero defects' as possible.
- Six sigma is a statistical term that measures process deviation from process mean or target. The figure of six was arrived statistically by looking at the current average maturity of most business enterprises.

43. (b)

Taguchi loss function defines that "the loss of a product costs to the society from the time the product is released for shipment".

- Defective products that are detected, repaired, reworked or scrapped before shipment are not considered as a part of this loss.
- It is a useful concept in tolerance design.
- Taguchi loss function uses a quadratic equation to describe the curve between loss and loss function.

$$L(x) = k(x - T)^2$$

T = Its nominal value

x = The quality characteristics of interest

k = Constant

44. (d)

- MTBF refers to the time between failure.
- MTBF is for repairable items.
- MTBF excludes down time

$$\text{MTBF} = \frac{1}{\text{Failure frequency}}$$

- Downtime is the period during which device is in the failed state.

45. (c)

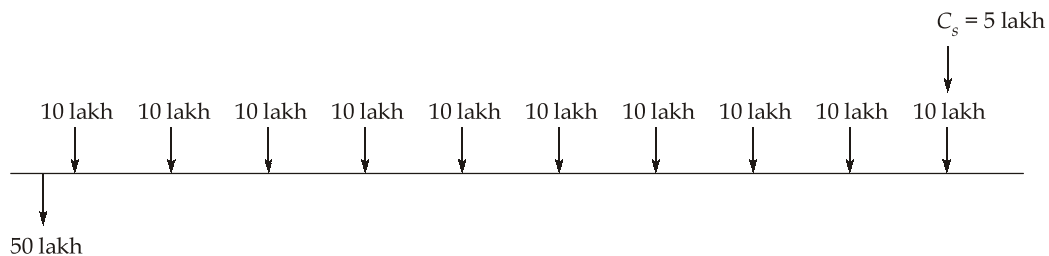
Appraisal cost : It is the cost associated with measuring, evaluating, discovering the defective part withing the production system. It includes cost related with inspection cost, cost of equipments, lab cost, auditing cost, prototype testing cost etc.

46. (b)

47. (c)

Project charter outlines what the project has to achieve (scope of work) and how to achieve the stated objectives and gives the project manager the authority to use company resources.

48. (b)



Annuity, A = ₹10 lakh

$$\begin{aligned} \text{Present worth of inflow} &= A \left[\frac{(1+i)^{10} - 1}{i(1+i)^{10}} \right] + \frac{S}{(1+i)^{10}} \\ &= \left[10 \left(\frac{(1.15)^{10} - 1}{0.15(1.15)^{10}} \right) + \frac{5}{(1.15)^{10}} \right] \text{lakh} \\ &= \frac{10}{0.15} [1 - 0.25] + 5(0.25) = 50 + 1.25 \text{ lakh} \\ &= ₹51.25 \text{ lakh} \end{aligned}$$

49. (c)

50. (d)

51. (b)

52. (b)

53. (d)

54. (d)

55. (a)

$$\text{Interplanar distance, } d = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$

For (1 1 0) plane,

$$d = \frac{\sqrt{2}}{\sqrt{1^2 + 1^2 + 0^2}} = 1\text{Å}$$

As per Bragg's law, $2d\sin\theta = n\lambda$, where n is the order of reflection

$$n = \frac{2d\sin\theta}{\lambda}$$

for maximum order of Bragg's deflection, $\theta = 90^\circ$

$$n = \frac{2 \times 1}{1}$$

$$n = 2$$

56. (b)

Babbitt metal is a soft, white non-ferrous alloy that is used to provide a bearing surface. They consists of soft matrix in which hard particles are embedded. Babbitts may be lead based (as 75%Pb, 15%Sb, 10%Sn) or tin-based (as 89%Sn, 8%Pb, 3%Cu). They use lead or tin as a soft matrix metal and hard particles of Sb-Sn or Cu-Sn to resist wear.

1. Lead based babbitts:

- Used for low pressure and low load bearing application.

2. Tin based babbitts:

- Used for high pressure and high load bearing application.
- Tin based babbitts have excellent corrosion resistance over lead based babbitts.

57. (a)

| Brass | Composition | Uses (Application) |
|-----------------|-----------------------------|---|
| Muntz metal | 60% Cu + 40% Zn | Used in valves, marine fitting, plumping operation |
| Catridge brass | 70% Cu + 30% Zn | Used in cold presswork and tubes sheets. |
| Aluminium brass | 77.5% Cu + 20.5% Zn + 2% Al | Used in chemical equipments and Heat exchanger tubes in power plants. |
| Red brass | 5% to 20% Zn and Rest Cu | Used in rivets, radiators, plumbing operation |
| Admiralty brass | 70% Cu + 29% Zn + 1.% Sn | Used in heat exchanger tubes of condensor in power plants. |

58. (c)

Scuffing is a moderate form of adhesive wear characterized by scratches or deformation aligned with the direction of motion. Surfaces that are said to have scuffed become so rough that they no longer provide their expected function.

59. (b)

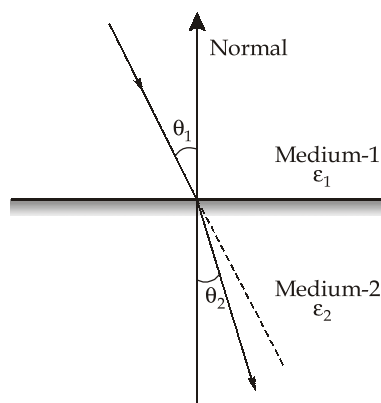
On the basis of intermolecular forces, the polymers are classified as:

- **Elastomers:** They have weak intermolecular forces because they are elastic in nature.
- **Fibres:** The forces of attraction between the polymeric chains are hydrogen bonding which is the stronger force of attraction.
- **Plastics:** They possess intermolecular forces of attraction and are intermediate between elastomers and fibres.

60. (d)

Given that,

$$\epsilon_1 = 7, \epsilon_2 = 2, \theta_1 = 60^\circ \text{ and } \theta_2 = ?$$



The tangential components of the electric field is continuous,

$$E_{1t} = E_{2t}$$

\Rightarrow

$$E_1 \sin \theta_1 = E_2 \sin \theta_2$$

The normal components of the electric flux density is continuous,

$$D_{1n} = D_{2n}$$

\Rightarrow

$$\epsilon_1 E_1 \cos \theta_1 = \epsilon_2 E_2 \cos \theta_2$$

From the above two equations,

$$\frac{\tan \theta_1}{\tan \theta_2} = \frac{\epsilon_1}{\epsilon_2}$$

$$\frac{\tan 60^\circ}{\tan \theta_2} = \frac{7}{2} = 3.5$$

$$\tan \theta_2 = \frac{1.732}{3.5}$$

$$\theta_2 = \tan^{-1}(0.4948) = 26.32^\circ$$

61. (a)

$$\begin{aligned} \text{Magnetic flux density, } \vec{B} &= \mu_0 \mu_r \vec{H} = \mu_0 (1 + x_m) \vec{H} \\ &= 4\pi \times 10^{-7} \times \mu_0 (1 + 1.4 \times 10^{-3}) \times 10^6 \\ &= 1.258 \text{ Weber/m}^2 \end{aligned}$$

62. (d)

Based on ϵ_r , ceramics are classified as:

- $\epsilon_r < 12$: Used as insulators. Ex: Porcelain, Steatite, Alumina
- $\epsilon_r > 12$: Used in capacitor applications Ex: Titanate

63. (d)

- A dislocation can be characterized by the relationship between its burgers vector and the tangent vector. For edge dislocations, the Burgers vector is perpendicular to the tangent vector whereas for Screw dislocations, the Burgers vector is parallel to the tangent vector and for mixed dislocation, the Burgers vector and the tangent vector are oriented at an angle between 0° and 90° .
- For any dislocation, the Burgers vector is invariant (i.e. constant) and does not vary from position to position.

Thus, all the statements are correct.

64. (b)

- Ceramics exhibit high electrical resistivity which prevents the flow of electrical current, making them valuable in electrical insulating applications, such as in electronic components and insulators. Thus, statement 1 is not correct.
- Cermets combine the hardness of ceramics and the toughness of metals, making them ideal for high-temperature and wear-resistant applications.

65. (d)

Radius of Neon atom,

$$R = 0.25 \text{ nm} = 0.25 \times 10^{-9} \text{ m}$$

Electronic polarizability,

$$\alpha_e = 4\pi\epsilon_0 R^3$$

$$= 4\pi \times \frac{1}{36\pi} \times 10^{-9} \times (0.25 \times 10^{-9})^3 = 1.736 \times 10^{-39} \text{ Fm}^2$$

66. (d)

Put

$$z - 1 = t$$

$$z = t + 1$$

We get,

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

$$= t \{1 - 2t + 3t^2 - 4t^3 + \dots\}$$

$$= t - 2t^2 + 3t^3 - 4t^4 + \dots$$

$$= (z-1) - 2(z-1)^2 + 3(z-1)^3 - 4(z-1)^4 + \dots$$

67. (a)

Given :

$$x^2 y'' + 6xy' + 6y = x$$

Put $x = e^t$ \Rightarrow

$$t = \ln x$$

We get,

$$x \frac{dy}{dx} = Dy \text{ and } x^2 \frac{d^2y}{dx^2} = D(D-1)y$$

where $D = d/dt$. Thus, the differential equation can be written as,

$$D(D - 1)y + 6Dy + 6y = e^t \quad \text{where } D = \frac{d}{dt}$$

$$(D^2 + 5D + 6)y = e^t$$

Auxiliary equation (AE) is $D^2 + 5D + 6 = 0$

$$\Rightarrow (D + 2)(D + 3) = -2, -3$$

$$\text{Complementary function} = c_1 e^{-2t} + c_2 e^{-3t} = c_1 x^{-2} + c_2 x^{-3}$$

68. (c)

Given : $\frac{dy}{dx} + \frac{y}{x} = \log x$ with $y(1) = 1$

The differential equation is linear differential equation.

$$\text{I.F.} = e^{\int \frac{1}{x} dx} = x$$

The solution is

$$xy = \int \log x \cdot x dx$$

$$xy = \log x \cdot \left(\frac{x^2}{2} \right) - \frac{x^2}{4} + C$$

Since,

$$y(1) = 1$$

$$C = \frac{5}{4}$$

The solution is

$$y = \frac{x}{2} \log x - \frac{x}{4} + \frac{5}{4x}$$

69. (c)

By trapaziodal rule

$$\int_a^b f(x) dx = \frac{h}{2} [(y_0 + y_n) + 2(y_1 + y_2 + \dots + y_{n-1})]; h = \frac{b-a}{n}$$

For two sub-intervals, $n = 2$. Thus, we get $h = 5$.

| x | 0 | 5 | 10 |
|-----------------|--------|--------|--------|
| $y = \sin(1-x)$ | 0.8414 | 0.7568 | -0.412 |

So,

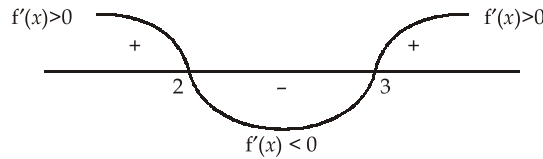
$$\begin{aligned} f(x) &= \frac{5}{2} [(0.8414 - 0.412) + 2(0.7568)] \\ &= 4.85 \approx 5 \end{aligned}$$

70. (b)

$$\begin{aligned} f'(x) &= 6x^2 - 30x + 36 \\ &= 6(x-2)(x-3) \end{aligned}$$

So, $f'(x) > 0$ when $x < 2$ and also when $x > 3$. Thus, $f(x)$ is increasing in the interval $(-\infty, 2] \cup [3, \infty)$.

OR, by Wavy-Curve Method



71. (b)

The given circle $|z| = 3$ with centre at $z = 0$ and radius 3 encloses both the poles $z = 1$ and $z = 2$.

$$\oint_c \frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)(z-2)} dz = \oint_{c_1} \frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)} dz + \oint_{c_2} \frac{\sin \pi z^2 + \cos \pi z^2}{(z-2)} dz$$

Using Cauchy's residue Theorem,

$$\begin{aligned} I &= 2\pi i \left[\frac{\sin \pi z^2 + \cos \pi z^2}{z-2} \right]_{z=1} + 2\pi i \left[\frac{\sin \pi z^2 + \cos \pi z^2}{z-1} \right]_{z=2} \\ &= 2\pi i \left(\frac{\sin \pi + \cos \pi}{1-2} \right) + 2\pi i \left(\frac{\sin 4\pi + \cos 4\pi}{2-1} \right) \\ &= 2\pi i + 2\pi i = 4\pi i \end{aligned}$$

72. (a)

The probability that A cannot solve the problem $= 1 - \frac{1}{2}$

The probability that B and C cannot solve the problem are $\left(1 - \frac{3}{4}\right)$ and $\left(1 - \frac{1}{3}\right)$ respectively.

$$\begin{aligned} \therefore \text{The probability that A, B and C cannot solve problem} &= \left(1 - \frac{1}{2}\right) \times \left(1 - \frac{1}{3}\right) \times \left(1 - \frac{1}{3}\right) \\ &= \frac{1}{2} \times \frac{1}{4} \times \frac{2}{3} = \frac{1}{12} \end{aligned}$$

73. (d)

For the differential equation $Mdx + Ndy = 0$,

If $\frac{\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}}{N} = f(x)$ i.e. depends only on x , then IF $= e^{\int f(x) dx}$

If $\frac{\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y}}{M} = f(y)$ i.e. depends only on y , then IF $= e^{\int f(y) dy}$

Thus, both the statements are not correct.

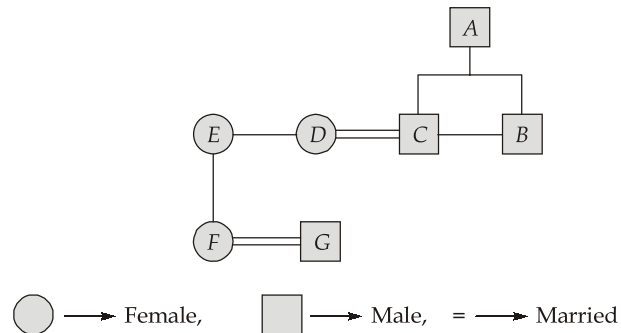
74. (b)

One-dimensional heat flow equation is given by $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$

75. (a)

76. (a)

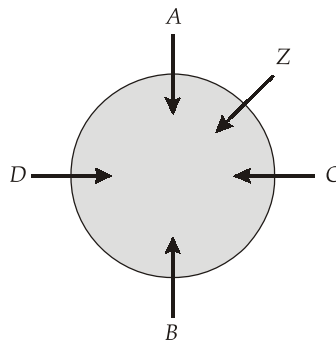
According to the given information, the family tree can be drawn as below,



Thus, there are four males in the family.

77. (c)

According to the question, the final seating arrangement is as follows:



We can see C is sitting to the immediate left of Z.

78. (c)

Let the principal be ' P '

According to the question,

Principal doubles itself in 10 years, thus principal ' P ' will become ' $2P$ ' in 8 years.

Also the amount ' $2P$ ' will become twice, i.e. ' $4P$ ' in next 8 years as the rate of interest is same.

Thus, the principal ' P ' will become ' $4P$ ' in $8 + 8 = 16$ years.

79. (b)

There are 3 consonants and 3 vowels E, A and O. Since no two vowels have to be together, the possible places for vowels are marked as 'X' and places for the consonants are marked as 'Y'.

We get, the arrangement as XYXYXYX. Here, the 3 vowels can be arranged in 4P_3 ways and 3 consonants can be arranged in 3P_3 ways.

Hence, the required number of ways = $3! \times {}^4P_3 = 144$.

80. (d)

We know that,
$$\text{Speed} = \frac{\text{Distance}}{\text{Time taken}} = \frac{384}{12} = 32 \text{ m/sec}$$

As length of the other train is same, thus while crossing the train,

Total distance = 768 meters

Total time = 12 seconds

Let speed of the second train is 'x' m/s. Since, the trains are travelling in opposite direction, the relative speed = $(x + 32)$ m/sec. We have,

$$12 = \frac{768}{x + 32} \Rightarrow x = 32 \text{ m/sec}$$

81. (b)

Let the distance between Mr. Kumar's home and his office is x km, then

$$\begin{aligned} \frac{0.6x}{48} - \frac{0.4x}{48} &= \frac{10}{60} \\ 0.2x &= 8 \\ x &= 40 \text{ km} \end{aligned}$$

82. (b)

83. (c)

| Month | Subject | Lecturer |
|----------|---------|----------|
| January | E | R |
| February | B | P |
| March | A | Q |
| April | C/D | S/T |
| May | D/C | T/S |

84. (d)

Government constituted the National Investment Fund (NIF) in 2005 into which the proceeds from disinvestment of Central Public Sector Enterprises were to be channelised.

85. (c)

- India has officially joined the US-led Minerals Security Finance Network, an initiative aimed at strengthening global cooperation in securing critical mineral supply chains. This framework was established by the US in 2022.

- China dominates global mineral refining, processing 68% of nickel, 40% of copper, 59% of lithium, and 73% of cobalt. It leads in producing 20 critical minerals, accounting for 60% of global production and 85% of rare earth processing.
- Critical minerals are minerals that are essential for the technological and manufacturing needs of companies, industries, and nations. They are crucial for the clean energy transition and digital technologies.

86. (c)

- Ethics refers as general and abstract concepts of right and wrong behavior culled from philosophy, theology, and professional societies.
- A moral precept is an idea or opinion that's driven by a desire to be good.

87. (b)

88. (c)

In aquatic ecosystems, the Grazing Food Chain serves as the primary pathway for energy flow. In contrast, in terrestrial ecosystems, a significantly greater proportion of energy flows through the detritus food chain compared to the Grazing Food Chain.

89. (d)

Gross primary productivity of an ecosystem is the rate of production of organic matter during photosynthesis.

90. (c)

In contrast to terrestrial ecosystems, in many aquatic ecosystems, the pyramid of biomass may assume an inverted form. (In contrast, a pyramid of numbers for the aquatic ecosystem is upright). This is because the producers are tiny phytoplankton that grow and reproduce rapidly. Here, the pyramid of biomass has a small base, with the consumer biomass at any instant exceeding the producer biomass and the pyramid assumes an inverted shape.

91. (b)

Bandwidth is the range of frequencies required so that all components of the signal can be transmitted without distortion or loss. As per the Shannon-Hartley Theorem, greater bandwidth allows more data to be transmitted. Thus, Both Statement (I) and Statement (II) are true but Statement (II) is not a correct explanation of Statement (I).

92. (a)

Laser printers laser beams your print onto a metal drum. It works by using a heated wire to positively charge a drum, which is then passed over by a laser that reverses the charge in the areas that it hits. The now-negatively charged areas of the drum represents the image or text that is to be printed.

93. (c)

There is slippage in belt drives, the slippage of belt over the pulleys is also responsible to absorb shocks and vibrations.

94. (d)

Lead time can increase for any inspection and for correction of quality related problems in manufacturing. By improving quality, the firm can eliminate time consuming activities such as inspection and rework and thereby reduce the lead time.

95. (a)

96. (d)

If there are heavy time penalties, the resources must be increased to meet the schedule. This is called time-limited resource scheduling.

97. (d)

- When a company desires a strong matrix, the project manager is generally promoted from within the organization and may have had assignments in several line functions throughout the organization.
- In a weak matrix, the company may hire from outside the organization but should at least require that the person selected understand the technology and the industry.

Resource-limited resource scheduling is used if the maximum number of resources is fixed and the end date might need to be extended to address any overload.

98. (d)

The production of nodular cast iron involves the changing of gray cast iron from flake form to nodular or spherical form by adding magnesium to the molten cast iron.

99. (a)

A crystallographic anisotropic material such as aluminium, may behave as an isotropic material if it is in a polycrystalline form. This is due to the random orientations of different crystals in a polycrystalline material, which will mostly cancel out any effect of the anisotropy as a result of crystal structure.

100. (a)

The inverse piezoelectric effect is used to produce ultrasound waves by applying an electric field to a piezoelectric material, such as quartz, causing it to mechanically vibrate at high frequencies. When these ultrasonic waves strike a quartz crystal, the resulting mechanical stress generates a potential difference across its surfaces due to the direct piezoelectric effect. Thus, Quartz crystals can be used both for generation of ultrasonic waves as well as for their detection.

