DETAILED SOLUTIONS

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ESE 2024 : Prelims Exam | CLASSROOM TEST SERIES | GS & ENGINEERING APTITUDE | Test 5

Section A : General Principles of Design, Drawing, Importance of Safety [All Topics]

Section B : Basics of Energy and Environment [All Topics]

Section C : Basics of Material Science [All Topics]

Answer Key

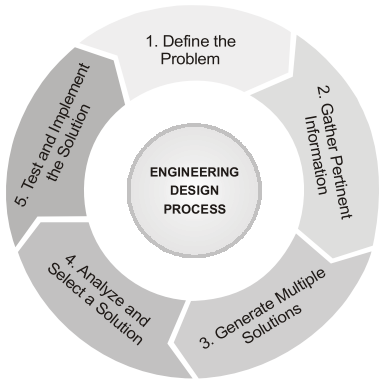
1.	(c)	11.	(b)	21.	(d)	31.	(d)	41.	(b)
2.	(c)	12.	(a)	22.	(d)	32.	(a)	42.	(d)
3.	(b)	13.	(d)	23.	(c)	33.	(b)	43.	(d)
4.	(b)	14.	(c)	24.	(b)	34.	(b)	44.	(c)
5.	(b)	15.	(a)	25.	(b)	35.	(d)	45.	(c)
6.	(a)	16.	(c)	26.	(d)	36.	(c)	46.	(b)
7.	(c)	17.	(c)	27.	(d)	37.	(c)	47.	(d)
8.	(b)	18.	(d)	28.	(c)	38.	(d)	48.	(a)
9.	(a)	19.	(b)	29.	(a)	39.	(d)	49.	(b)
10.	(b)	20.	(b)	30.	(d)	40.	(c)	50.	(d)

DETAILED EXPLANATIONS

1. (c)

Original design or innovative design is at the top of the hierarchy. A truly original design involves invention. Successful original design's occur rarely, but when they occur, they disrupt and overtake exiting markets.

2. (c)



Steps in Engineering Design Process

3. (b)

The embodiment design process is the bridge between the conceptual stage of the design process and the detail design stage. A more detailed analysis of the selected concepts is undertaken in the embodiment stage of the design process.

4. (b)

Concurrent engineering is a non-linear product design process during which all stages of manufacturing operate at the same time.

6. (a)

Edward De Bono coined the term "Lateral thinking" the act of cutting across thought patterns. One of the key tenets of lateral thinking is the concept that an act of provocation is needed to make the brain switch from one pattern of thought to another.

7. (c)

- Spider map is a basic mind map connecting a topic to sub-topics. It is best for brainstorming.
- System map is a system structure that displays relationships and processes within a system and its environment. It is best for combined organizational and process planning.

8. (b)

EVAD (Design EVAluation) method do not makes attempt at ranking or weighting the criteria. It is a method particularly recommended for the evaluation and selection of new product ideas but it can be also be applied to concept selection.

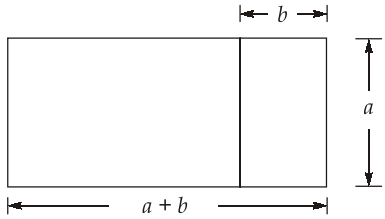
In this method, a list of evaluation criteria is established and each criterion is standardized according to the strategic objectives of the company. For example, one criterion, product image, could have

standards set an modern exclusive (++), modern ordinary (+), traditional (–) and outdated (– –). From the concept description scores for each criterion are established. These results are entered on a diagram giving an evaluation profile for each idea. The profiles are compared in a qualitative rather than quantitative way.

9. (a)

DFM will allow potential problems to be fixed in the design phase which is the least expensive place to address them.

10. (b)



Golden ratio is the ratio is the sum of two numbers and the larger number.

$$\frac{a+b}{a} = \frac{a}{b}$$

$$ab + b^2 = a^2$$

$$a^2 - b^2 - ab = 0$$

$$\Rightarrow \quad a = \frac{1+\sqrt{5}}{2} \qquad [\text{Keeping, } b = 1]$$

$$a = 1.618$$

12. (a)

Types of lines and their uses

Lines	Description	Applications
A ———	Continuous thick	Visible outlines Visible edges
B ———	Continuous thin	Dimension lines Projection lines Leader lines Hatching
C ——/\/\——	Continuous thin with zigzags	Long-break line
D - - - - - -	Dashed line	Hidden outlines Hidden edges
E —·—·—·—	Chain thin	Centre line Lines of symmetry Trajectories pitch circle of holes and gears
F —·—·—·—┐ └·—·—·—	Chain thin, thick at ends and change in direction	Cutting planes

13. (d)

Rules to Maximize Workers' Safety

Certain rules to be followed to ensure safety of workers include:

- Always be sure that moving mechanisms are clear of people and objects.
- Be sure that workers are not wearing any jewelry or loose clothing that could get snagged in the machine.
- Keep an eye on overhead parts, like pulleys, for potential hazards.
- Check that guards are in place at all points where could contact moving parts before turning the machine on.
- Be aware of how to turn power on and off if you should have gone to do so quickly.
- Read the manufacturer's instructions on how to operate the machine safely and correctly.
- Feed material and into the machine with push sticks, not with hands.
- Make sure maintenance is performed when required.
- Use lockout/tagout procedures, when a machine needs repair or maintenance.

14. (c)

Internationally accepted classification of fires are as follows:

1. Class 'A' : Fires involving solid material normally of an organic nature (compounds of carbon).
2. Class 'B' : Fires in flammable liquids such as gasoline, petroleum, greases, tars, oils, oil based paints, solvents, alcohols.
3. Class 'C' : Fires involving gases or liquified gases in the form of a liquid spillage or a liquid or gas leak and these include methane, propane, butane, etc.
4. Class 'D' : Fires involving metals.

15. (a)

The number of people in between floor landings in staircase shall not be less than the population on each floor for the purpose of design of staircase.

16. (c)

Don't attempt to oil, clean, adjust or repair any machine while it is running, stop the machine and lock the power switch in the off position.

17. (c)

Feller buncher is the tree cutting heavy equipment used to remove large trees in construction field. They cut the tree and grade it without felling, likewise gathers all the cut down trees at one place, which makes job easier for loaders and dump trucks.

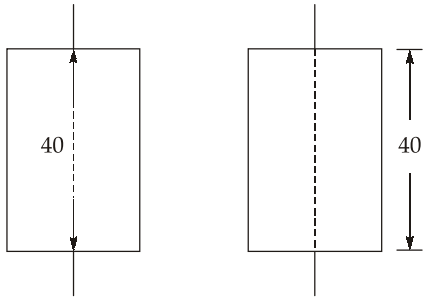
18. (d)

Sphere is double curved surface hence its surface is non-developable. Only approximation methods are available for development of sphere. Two approximate methods available are:

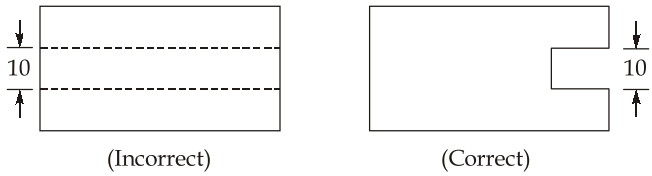
1. Lune method or poly cylindric method.
2. Zone method or poly conic method.

20. (b)

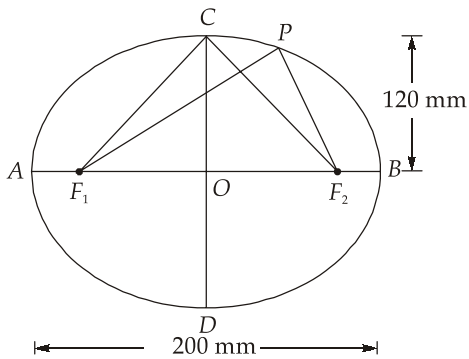
- Centre line (axis) itself shall not be used as a dimension line with arrow loads at its ends.



- Dimensions shall be given to visible lines and not to hidden (invisible) lines.



22. (d)



Distance of ends of minor axis from focus is equal to half of the major axis.

$$CF_1 = \frac{AB}{2} = AO = 100 \text{ mm}$$

Semi-minor axis, $CO = 60$ mm

$$\therefore \quad \frac{F_1F_2}{2} = \sqrt{(CF_1)^2 - (CO)^2} = \sqrt{100^2 - 60^2} = 80$$

$$\Rightarrow \quad F_1F_2 = 2 \times 80 = 160 \text{ mm}$$

Hence, the distance between focus is 160 mm.

23. (c)

Oblique projection

(a) Cabinet projection
(b) Cavalier projection
(c) Clinographic projection
(d) Shades and shadows

Axonometric projection

(a) Isometric projection
(b) Diametric projection
(c) Trimetric projection

25. (b)

The representative factor is

$$\text{R.F.} = \sqrt[3]{\frac{\text{Volume of model}}{\text{Volume of actual object}}}$$

$$= \sqrt[3]{\frac{512}{4096 \times 10^6}} = \frac{1}{200}$$

27. (d)

- An algal bloom or algae bloom is a rapid increase or accumulation in the population of algae in freshwater or marine water systems. It is often recognized by the discoloration in the water from the algae's pigments.
- The term algae encompass many types of aquatic photosynthetic organisms, both macroscopic multicellular organisms like seaweed and microscopic unicellular organisms like cyanobacteria. An example of a macroscopic algal bloom is a kelp forest.

31. (d)

- World Ozone Day is celebrated on 16th September each year to commemorate the signing of the Montreal Protocol, an international environmental treaty for phasing out of production and consumption of Ozone Depleting Substances, that came into force on this day in 1987.
- Montreal Protocol and its amendments are successful in eliminating up to 99% of Ozone Depleting Substances (ODS) (long-lived man-made chemicals which destroy the protective ozone layer).
- India has been proactive in implementing the Montreal Protocol, phasing out harmful substances and achieving reductions.
- India Cooling Action Plan (ICAP) to address refrigerant transition, energy efficiency, and technology advancement in cooling systems.

33. (b)

Coral reefs cover less than 0.5% of the earth's surface, but they are home to about 25% of all marine species.

35. (d)

In India, elephant reserves and corridors have no legal sanctity under any law, including the Wildlife Protection Act (WLPA), 1972. The act mentions only national parks, wildlife sanctuaries, conservation and community reserves (collectively called Protected Areas).

39. (d)

All the given factors influence the packing, symmetry, and structure of crystalline materials.

40. (c)

- An edge dislocation moves in the direction of burger's vector and lies perpendicular to its burger's vector.
- A screw dislocation moves in a direction perpendicular to burger's vector and lies parallel to its burger's vector.
- Stacking faults are two-dimensional planar defects that occur within the crystal structure of a material, not on its surface. They arise from disruptions in the regular stacking sequence of atomic planes in the crystal lattice.

41. (b)

Ledeburite is the eutectic mixture of austenite and cementite. It contains 4.3% carbon and it is formed at about 1130°C.

42. (d)

The purpose of tempering is to

- Relieve residual stresses
- Improve ductility
- Improve toughness
- Reduce hardness
- Increase percentage elongation

43. (d)

Pitting corrosion is a form of extremely localized corrosion that leads to the random creation of small holes in metal. The driving power for pitting corrosion is the depassivation of a small area, which becomes anodic (oxidation reaction) while an unknown but potentially vast area becomes cathodic (reduction reaction), leading to very localized galvanic corrosion.

44. (c)

True fracture stress is given by,

$$\sigma_{TF} = \frac{\sigma_F \cdot A_0}{A_F} = \frac{500 \times 15^2}{10^2}$$

$$\therefore \quad \sigma_{TF} = 1125 \text{ MPa}$$

45. (c)

Silver oxidation is slower than that of copper as Silver's ionization energy is 2.959 eV, while copper's ionization energy is 2.56 eV. Hence, silver has a high resistance to oxidation.

46. (b)

Manganese ferrite is a 1 : 1 mixture of manganese oxide and iron oxide.

47. (d)

- According to the orbital overlap concept, atoms combine by overlapping their orbital and thus, forming a lower energy state where their valence electrons with opposite spin, pair up to form covalent bonds.
- Valence band is the highest range of electron energies in which electrons are present normally at zero temperature.
- Some energy bands like conduction band may be unfilled.

48. (a)

Stored energy, $W = \frac{1}{2}\vec{P}\cdot\vec{E}$

$\vec{P} \rightarrow$ Polarization

$\vec{E} \rightarrow$ Applied Electric field

49. (b)

Stored energy, $E_1 = \frac{1}{2}CV^2$ (without dielectric)

and $E_2 = \frac{1}{2}kCV^2$ (with dielectric)

(as C increases 'k' times with introduction of dielectric where, k is dielectric constant)

It is given that $E_2 = 3E_1$, hence $k = 3$.

50. (d)

Eddy current loss, $P_{eddy} = K_e f^2 B_{max}^2 t^2$

Also, $K_e = \frac{\pi^2}{\rho} = \pi^2\sigma$ ($\sigma \rightarrow$ conductivity)

$P_{eddy} = \pi^2 \sigma f^2 B^2_{max} \times t^2$

$\Rightarrow$ $P_{eddy} \propto \sigma$

$\therefore$ $\frac{P_{eddy\,A}}{P_{eddy\,B}} = \frac{4}{9}$

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