General Studies and Engineering Aptitude
PRACTICE BOOK

3300+
Topicwise Solved Questions

- Engineering Aptitude Covering Logical Reasoning and Analytical Ability
- Engineering Mathematics and Numerical Analysis
- General Principles of Design, Drawing, Importance of Safety
- Standards and Quality Practices in Production, Construction, Maintenance and Services
- Basics of Energy and Environment • Basics of Project Management
- Basics of Material Science and Engineering • Information and Communication Technologies
- Ethics and Values in Engineering Profession

ESE Prelims : General Studies and Engineering Aptitude Practice Book

Preface

To get a thorough knowledge and to succeed in the growing competition in Engineering Services Examination reading just the theory will not suffice. To supersede other competitors, an aspirant needs a thorough practice of variety of questions. With the introduction of 9 Non Technical subjects and Current Affairs in Paper-I of ESE Prelims, it has become mandatory to get well versed with these subjects by getting acquainted with every possible variety of question. To help every aspirant to score high marks in the exam, MADE EASY has come up with revised edition of **General Studies and Engineering Aptitude Practice Book** – a 3300+ topicwise question bank. Now this book contains questions of ESE 2017, ESE 2018 and ESE 2019 alongwith two solved model papers for practice.

B. Singh (Ex. IES)

MADE EASY team has put sincere efforts in framing and compilation of questions with accurate explanations, supplemented with relevant theory and illustrations of subjects namely:

- Engineering Aptitude covering Logical Reasoning and Analytical Ability

- Engineering Mathematics and Numerical Analysis

- General Principles of Design, Drawing, Importance of Safety

- Standards and Quality Practices in Production, Construction, Maintenance and Services

- Basics of Energy and Environment

- Basics of Project Management

- Basics of Material Science and Engineering

- Information and Communication Technologies (ICT)

- Ethics and Values in Engineering Profession

For Current Affairs, students are advised to go through the MADE EASY Current Affairs Magazine Annual Edition.

It is impossible to acknowledge all the individuals who helped us, but would like to sincerely thank all authors, editors and reviewers for putting their painstaking efforts to publish this book.

With Best Wishes

B. Singh

CMD, MADE EASY

General Studies and Engineering Aptitude : Practice Book

Contents

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Engineering Aptitude Covering Logical Reasoning and Analytical Ability

1. Number Systems

Q.1 What will come in place of the question mark(?) in the following number series?
5 7 ? 25 45 75
(a) 11   (b) 13
(c) 15   (d) 19

Q.2 What should come in place of question mark(?) in the following number series?
132 156 ? 210 240 272
(a) 196   (b) 182
(c) 199   (d) 204

Q.3 Simplify the following equation
$2003 \times 2004 - 2001 \times 2002 = ?$
(a) 8010   (b) 8020
(c) 8030   (d) 8040

Q.4 If R and S are different integers both divisible by 5, then which of the following is not necessarily true?
(a) R – S is divisible by 5
(b) R + S is divisible by 10
(c) R × S is divisible by 25
(d) R2 + S2 is divisible by 5

Q.5 What will come in place of the question mark(?) in the series?
3, 8, 27, 112, (?), 3396
(a) 565   (b) 452
(c) 560   (d) 678

Q.6 Police officers of a particular batch are preparing for a drill and are made to stand in different rows. If 4 officers are extra in each row, then there would be 2 rows less. But there would be 4 more rows if 4 officers are less in each row. Find the number of officers in the batch?
(a) 96   (b) 56
(c) 69   (d) 65

Q.7 Father said his son, "I was as old as you are at present at the time of your birth. "If the father age is 38 now, the son age 5 years back was:
(a) 14   (b) 19
(c) 33   (d) 38

Q.8 In a two-digit number, the digit in the unit's place is more than twice the digit in ten's place by 1. If the digits in the unit's place and the ten's place are interchanged, difference between the newly formed number and the original number is less than the original number by 1. What is the original number?
(a) 35   (b) 36
(c) 37   (d) 39

Q.9 Fill in the blank indicated by a star in the number 4 ∗ 56 so as to make it divisible by 33.
(a) 3   (b) 4
(c) 5   (d) None of these

Q.10 What will come in place of the question mark(?)
82 : 06 :: 76 : ?
(a) 15   (b) 01
(c) 12   (d) 24

Q.11 What will come in place of the question mark(?)
121, 222, 424, ?
(a) 646   (b) 828
(c) 626   (d) 524

Q.12 What will come in place of the question mark(?)
2, 3, 5, 9, 17, ?
(a) 31   (b) 32
(c) 33   (d) 34

Q.13 What will come in place of the question mark(?)
23 : 13 :: 54 : ?
(a) 40   (b) 41
(c) 44   (d) 39

Q.14 Three hundred passengers are travelling in white, silver and black cars; each of these cars is carrying 6, 5 and 3 passengers, respectively. If the number of white and silver cars is equal and three is only one black car, what is the total number of cars?
(a) 52   (b) 53
(c) 54   (d) 55

[ESE Prelims 2017]

Q.15 A total of 324 notes comprising of ₹ 20 and ₹ 50 denominations make a sum of ₹ 12,450. The number of ₹ 20 notes is

(a) 200   (b) 144
(c) 125   (d) 110

[ESE Prelims 2017]

Q.16 The sum of squares of successive integers 8 to 16, both inclusive, will be
(a) 1126   (b) 1174
(c) 1292   (d) 1356

[ESE Prelims 2018]

Q.17 In a particular test, the marks scored by 4 candidates – A, B, C and D are as follows:
- Marks obtained by A and B add to 100;
- Marks obtained by C and D add up to those scored by A;
- B scores 4 times of D;
- D scores 10 marks less than C.

The marks obtained by C will be
(a) 30   (b) 15
(c) 20   (d) 25

[ESE Prelims 2018]

Q.18 Let the sum of the squares of successive integers 0, 1, 2, ..., $n - 1$, n be denoted by S. Let the sum of the cubes of the same integers be denoted by C. It is desirable that $\dfrac{C}{S}$, as n increases in steps of 'unity' from 'zero', is given by the series:

$$\frac{0}{1}, \frac{3}{3}, \frac{9}{5}, \frac{18}{7}, \frac{30}{9}, \cdots \text{ (for } n = 0, 1, 2, 3, 4 ....).$$ What will this ratio be for $n = 8$?

(a) $\dfrac{108}{17}$ (b) $\dfrac{103}{17}$

(c) $\dfrac{103}{15}$ (d) $\dfrac{100}{15}$

[ESE Prelims 2018]

2. Percentage

Directions (Q.19 to Q.20): Answer the questions on the basis of the information given below:

In an examination, there are 100 questions divided into three groups A, B and C such that each group contains atleast one question. Each question in group A carries 1 mark, each question in group B carries 2 marks and each question in group C carries 3 marks. It is known that the questions in group A together carry atleast 60% of the total marks.

Q.19 If group B contains 23 questions, then how many questions are there in group C?
(a) 1   (b) 2
(c) 3   (d) Cannot be determined

Q.20 If group C contains 8 questions and group B carries atleast 20% of the total marks, which of the following best describes the number of questions in group B?
(a) 11 or 12   (b) 12 or 13
(c) 13 or 14   (d) 14 or 15

Q.21 Anita's mathematics test had 70 problems carrying equal marks i.e., 10 arithmetic, 30 algebra and 30 geometry. Although she answered 70% of the arithmetic, 40% of the algebra and 60% of the geometry problems correctly, she did not pass the test because she got less than 60% marks. The number of more questions she would have to answer correctly to earn a 60% passing marks is:
(a) 1   (b) 5
(c) 7   (d) 9

Q.22 In a class, there are 18 very tall boys. If these constitute three-fourths of the boys and the total number of boys is two-thirds of the total number of students in the class, what is the number of girls in the class?
(a) 6   (b) 12
(c) 18   (d) 21

Q.23 Consider the following statements:
1. Either A and B are of the same age or A is older than B
2. Either C and D are of the same age or D is older than C
3. B is older than C

Which of the following conclusions can be drawn from the above statements?
(a) A is older than B
(b) B and D are of the same age
(c) D is older than C
(d) A is older than C

Q.24 The monthly average salary paid to all the employees of a company was ₹ 5000. The monthly average salary paid to male and female employees was ₹ 5200 and ₹ 4200 respectively. Then the percentage of males employed in the company is
(a) 75%   (b) 80%
(c) 85%   (d) 90%

Q.25 Two numbers X and Y are respectively 20% and 28% less than a third number Z. By what percentage is the number Y less than the number X?
(a) 12%   (b) 10%
(c) 9%   (d) 8%

Q.26 A piece of tin is in the form of a rectangle having length 12 cm and width 8 cm. This is used to construct a closed cube. The side of the cube is:
(a) 2 cm   (b) 3 cm
(c) 4 cm   (d) 7 cm

Q.27 In an election only two candidates contested 20% of the voters did not vote and 120 votes were declared as invalid. The winner got 200 votes more than his opponent thus he secured 41% votes of the total voters on the voter list. Percentage votes of the defeated candidate out of the total votes casted is:
(a) 47.5%   (b) 41%
(c) 38%   (d) 45%

Q.28 The total emoluments of two persons are the same, but one gets allowances to the extent of 65% of his basic pay and the other gets allowances to the extent of 80% of his basic pay. The ratio of the basic pay of the former to the basic pay of the latter is:
(a) 16 : 13   (b) 5 : 4
(c) 7 : 5   (d) 12 : 11

Q.29 When 75 is added to 75% of a number, the answer is the number. Find 40% of that number.
(a) 100   (b) 80
(c) 120   (d) 160

Q.30 An annual report consists of 20 sheets each of 55 lines and each line consists of 65 characters. This report is reduced into sheets each of 65 lines such that each line consists of 70 characters. The percentage reduction in the number of sheets will be:
(a) 30%   (b) 20%
(c) 5%   (d) 35%

Q.31 In an election between two candidates, one got 55% of the total valid votes, 20% of the votes were invalid. If the total number of votes was 7500, the number of valid votes that the other candidate got, was:
(a) 2500   (b) 2700
(c) 2900   (d) 3100

Q.32 If each side of a square is increased by 25%, find the percentage change in its area?

(a) 65.25   (b) 56.25
(c) 65   (d) 56

Q.33 If 20% of $a = b$, then b% of 20 is the same as:
(a) 4% of a (b) 6% of a
(c) 8% of a (d) 10% of a

Q.34 Fresh fruit contains 68% water and dry fruit contains 20% water. How much dry fruit can be obtained from 100 kg of fresh fruits?
(a) 20   (b) 30
(c) 40   (d) 50

Q.35 A candidate scoring 25% in an examination fails by 30 marks, while another candidate scores 50% mark, gets 20 marks more than the minimum pass marks. Find the minimum pass marks.
(a) 20   (b) 50
(c) 80   (d) 200

Q.36 In an election, a candidate who gets 84% of the votes is elected by a majority of 476 votes. What is the total number of votes polled?
(a) 900   (b) 810
(c) 600   (d) 700

Q.37 The salaries of A, B, and C are in the ratio of 1 : 2 : 3. The salary of B and C together is ₹ 6000. By what percent is the salary of C more than that of A?
(a) 100 %   (b) 200%
(c) 300%   (d) 600%

Q.38 There are 1650 students in a college. The difference between the number of boys and girls in the college is 400. What is the percentage of girls in the college?
(a) 49   (b) 34
(c) 43   (d) 38

Q.39 The length, breadth and height of a room are in the ratio 7 : 3 : 1. If the breadth and height are doubled while the length is halved, then by what percent the total area of the 4 walls of the room will be increased?
(a) 90%   (b) 88%
(c) 85%   (d) 84%

Q.40 Rajiv spends 40% of his salary on food, 20% on house rent, 10% on entertainment and 10% on conveyance. If his savings at the month end are ₹ 2,000, then his monthly salary is:
(a) ₹ 6,000   (b) ₹ 8,000
(c) ₹ 10,000   (d) ₹ 12,000
                                              [ESE Prelims 2017]

Answer Key : Engineering Aptitude Covering Logical Reasoning and Analytical Ability

1. (b)	2. (b)	3. (a)	4. (b)	5. (a)	6. (a)	7. (a)	8. (c)
9. (a)	10. (b)	11. (b)	12. (c)	13. (c)	14. (d)	15. (c)	16. (d)
17. (d)	18. (a)	19. (a)	20. (c)	21. (b)	22. (b)	23. (d)	24. (b)
25. (b)	26. (c)	27. (d)	28. (a)	29. (c)	30. (b)	31. (b)	32. (b)
33. (a)	34. (c)	35. (c)	36. (d)	37. (b)	38. (d)	39. (a)	40. (c)
41. (b)	42. (a)	43. (a)	44. (c)	45. (b)	46. (c)	47. (c)	48. (a)
49. (b)	50. (c)	51. (a)	52. (d)	53. (d)	54. (c)	55. (a)	56. (a)
57. (c)	58. (c)	59. (d)	60. (d)	61. (a)	62. (b)	63. (b)	64. (c)
65. (a)	66. (b)	67. (c)	68. (d)	69. (d)	70. (a)	71. (d)	72. (c)
73. (b)	74. (b)	75. (b)	76. (c)	77. (a)	78. (d)	79. (a)	80. (b)
81. (b)	82. (d)	83. (c)	84. (c)	85. (a)	86. (d)	87. (b)	88. (b)
89. (a)	90. (b)	91. (a)	92. (a)	93. (a)	94. (b)	95. (c)	96. (a)
97. (c)	98. (d)	99. (a)	100. (b)	101. (a)	102. (a)	103. (d)	104. (b)
105. (b)	106. (c)	107. (a)	108. (c)	109. (c)	110. (b)	111. (c)	112. (b)
113. (c)	114. (d)	115. (a)	116. (b)	117. (b)	118. (a)	119. (b)	120. (d)
121. (b)	122. (a)	123. (a)	124. (a)	125. (d)	126. (c)	127. (a)	128. (b)
129. (b)	130. (d)	131. (b)	132. (a)	133. (d)	134. (d)	135. (d)	136. (c)
137. (d)	138. (a)	139. (d)	140. (b)	141. (c)	142. (b)	143. (d)	144. (a)
145. (a)	146. (c)	147. (c)	148. (a)	149. (d)	150. (d)	151. (a)	152. (c)
153. (b)	154. (c)	155. (c)	156. (b)	157. (c)	158. (b)	159. (c)	160. (b)
161. (a)	162. (b)	163. (b)	164. (b)	165. (b)	166. (b)	167. (d)	168. (b)
169. (b)	170. (b)	171. (c)	172. (b)	173. (a)	174. (c)	175. (c)	176. (c)
177. (b)	178. (d)	179. (d)	180. (b)	181. (d)	182. (b)	183. (b)	184. (b)
185. (b)	186. (a)	187. (c)	188. (d)	189. (c)	190. (d)	191. (c)	192. (b)
193. (d)	194. (c)	195. (c)	196. (c)	197. (c)	198. (d)	199. (a)	200. (a)
201. (c)	202. (d)	203. (b)	204. (a)	205. (c)	206. (c)	207. (a)	208. (b)
209. (b)	210. (c)	211. (a)	212. (b)	213. (a)	214. (b)	215. (d)	216. (b)
217. (d)	218. (c)	219. (a)	220. (d)	221. (c)	222. (d)	223. (c)	224. (d)
225. (b)	226. (c)	227. (a)	228. (c)	229. (a)	230. (b)	231. (d)	232. (a)
233. (b)	234. (d)	235. (b)	236. (a)	237. (d)	238. (c)	239. (c)	240. (b)

Explanations : Engineering Aptitude Covering Logical Reasoning and Analytical Ability

1. **(b)**
   The series given follow the pattern
   +2, +2 + 4, +2 + 4 + 6, +2 + 4 + 6 + 8, +2 + 4 + 6 + 8 + 10,...
   Here ? = 7 + 2 + 4 = 13

2. **(b)**
   The given series follows a logic that
   11×12, 12×13, 13×14, 14×15, 15×16, ...
   So the missing number is $13 \times 14 = 182$

3. **(a)**
   $(2000 + 3)(2000 + 4) - (2000 + 1)(2000 + 2) = ?$
   Since $(2000 \times 2000) - (2000 \times 2000)$ is equal to zero ?
   $= (8000 + 6000 + 12) - (4000 + 2000 + 2)$
   $= 14012 - 6002$
   $= 8010$

4. **(b)**
   If R and S are multiple of 5, then R + S may or may not be divisible by 10.
   To solve such problems, always take actual values and check.
   For example, if R = 20 and S = 15, we can see that only option (b) is the right option.

5. **(a)**
   $3 \times 2 + 2 = 8$
   $8 \times 3 + 3 = 27$
   $27 \times 4 + 4 = 112$
   $112 \times 5 + 5 = 565$

6. **(a)**
   Let the number of officers in each row be x and the number of rows be y.
   Total number of officers = xy, According to question,
   $(x + 4)(y - 2) = xy$ ...(i)
   $(x - 4)(y + 4) = xy$ ...(ii)
   Solving (i) and (ii), we get:
   $x = 12$; $y = 8$
   Thus, total number of officers would be
   $= 2 \times 8 = 96$

7. **(a)**
   Let the son's present age be x years.
   Then, $(38 - x) = x$
           $x = 19$
   Son's age 5 years back = $(19 - 5) = 14$ years

8. **(c)**
   Let the ten's digit be x
   Then, unit's digit = $2x + 1$
   $[10x + (2x + 1)] - [\{10(2x + 1) + x\} - \{10x + (2x + 1)\}] = 1$
   $\Rightarrow (12x + 1) - (9x + 9) = 1 \Leftrightarrow 3x = 9, x = 3$
   So, ten's digit = 3 and unit's digit = 7
   Hence, original number = 37

9. **(a)**
   $4 * 56$ is divisible by 33 if and only if it is divisible by 3 and 11.
   $4 * 56$ will be divisible by 3 if $*$ will be equal to 0, 3, 6, 9.
   $4 * 56$ is divisible by 11 if $(4 + 5) - (* + 6)$ will be divisible by 11. So $*$ should be 3.

10. **(b)**
    82 means 8 – 2 = 06
    Similarly, 76 means 7 – 6 = 01

11. **(b)**
    121 > 222 > 424 > 828
    The first and the third digit get doubled.

12. **(c)**
    2 + 1 = 3
    3 + 2 = 5
    5 + 4 = 9
    9 + 8 = 17
    17 + 16 = 33

13. **(c)**
    As   23 – 10 = 13
    Similarly   54 – 10 = 44

14. **(d)**
    Since the number of passengers in Black car is 3, it leaves 300 – 3 = 297 passengers to be accommodated in White and Silver coloured cars which are equal in number ($W = S$).
    We can form a linear equation:
    $(6 + 5)W = 297$ giving $W = 27$ as also $S = 27$
    Total number of cars being 27 + 27 + 1 = 55

15. **(c)**
    We can form 2 linear equations taking the number of Rs. 20 and Rs. 50 notes as T and F
    $T + F = 324$ ...(1)
    $20T + 50F = 12450$ ...(2)

Solving the 2 equations, we get $T = 125$

Alt 1: If all the notes are Rs. 50 notes, total amount = 324×50 = Rs. 16200 which is 16200 − 12450 = 3750

$$\frac{3750}{(50-20)} = 125 \text{ notes of Rs. 20}$$

Alt 2: This question can also be solved by putting options.

16.   **(d)**

Apply formula for $\sum n^2$ to solve this question where

$$\sum n^2 = \frac{n(n+1)(2n+1)}{6}$$

$$\sum_{n=1}^{n=16} n^2 - \sum_{n=1}^{n=7} n^2 = \frac{16(16+1)(32+1)}{6} -$$

$$\frac{7(7+1)(14+1)}{6}$$

$$= 1496 - 140 = 1356$$

17.   **(d)**

$$A + B = 100$$
$$C + D = A$$
$$B = 4D$$
$$D = C - 10 \text{ or } C = D + 10$$
$$A + 4D = 100$$

and $D + D + 10 = A$

or $A = 2D + 10$

Solving these 2 equations given $D = 15$ and $C = 25$

18.   **(a)**

Ignoring 1st term, $\dfrac{c}{s} = \dfrac{\sum n^3}{\sum n^2} = \dfrac{\dfrac{\{n(n+1)\}^2}{2}}{\dfrac{n(n+1)(2n+1)}{6}}$

Putting, $n = 8$ we get $\dfrac{c}{s} = \dfrac{108}{17}$

19.   **(a)**

Group B contains 23 questions which carry 46 marks If group C contains 1 question which will carry 3 marks.

∴ Group A will contains 76 questions which will carry 76 marks.

∴   Total marks = 125

Now 76 marks of 125 marks are = 60·8%

Hence, group C will contain only 1 question.

20.   **(c)**

In group C there are 8 questions

→   24 marks

If in group B there are 14 questions

→   28 marks

∴ In group A there are 78 questions

→   78 marks

       Total mark = 130

∴ % marks in group B = 130 = 21·54

If in group B there are 13 questions! 26 marks

∴ Mark of group C = 24 and

Marks of group A = 79 = 26 × 100

∴   % marks in group B = 129 = 20·15%

Hence, group B contains either 13 or 14 questions.

21.   **(b)**

Number of more questions she would have to answer correctly to earn a 60% passing marks are 5.

22.   **(b)**

The number of girls in the class 12.

23.   **(d)**

A is older than C

24.   **(b)**

Percentage of males employed in the company is 80%.

25.   **(b)**

Number Y less than the number X by 10%.

26.   **(c)**

The side of the cube is 4 cm.

27.   **(d)**

Let there be x voters and k votes goes to loser then

$$0.8x - 120 = + (k + 200) \qquad ...(i)$$
$$k + 200 = 0.41x \qquad ...(ii)$$

So, $k = 1440$

and $(k + 200) = 640$

Therefore $\dfrac{1440}{3200} \times 100 = 45\%$

28.   **(a)**

The ratio of the basic pay of the former to the basic pay of the latter is 16 : 13.

29.   **(c)**

Let the number be x

$$x \times 0.75 + 75 = x$$

$$x \times \frac{3}{4} + 75 = x$$

So, $x = 300$

Hence, the 40% of x will be = 120

30. (b)

Value of report = $20 \times 55 \times 65$

Number of sheets finally used = 'N'

$N \times 65 \times 70 = 20 \times 55 \times 65$

$$N = \frac{110}{7} = 15.7 \approx 16$$

% reduction = $\frac{20-16}{20} = 20\%$

Hence, (b) is the correct option.

31. (b)

Total number of votes = 7500

Given that 20% of Percentage votes were invalid

$\Rightarrow$ Valid votes = 80%

Total valid votes = $7500 \times 0.8 = 6000$

1st candidate got 55% of the total valid votes.

Hence the 2nd candidate should have got 45% of the total valid votes

$\Rightarrow$ Valid votes that 2nd candidate got = Total valid votes $\times$ 0.45

= $7500 \times 0.8 \times 0.45 = 2700$

32. (b)

Let each side of the square be a, then area = $a \times a$

As given that The side is increased by 25%, then

New side = $0.125a$

New area = $(0.125a)(0.125a)$

Increased area = $\left(\frac{25}{16}\right)(a)(a) - (a)(a)$

Increase% = $\dfrac{\left(\left(\dfrac{25}{16}\right)(a)(a) - (a)(a)\right)}{(a.a)}$

= 56.25%

33. (a)

20% of $a = b$ means $0.20 \times a = b$

b% of 20 = $0.b \times 20 = 0.20 \times a \times 20 = 4\%$ of a.

34. (c)

The fruit content in both the fresh fruit and dry fruit is the same.

Given, fresh fruit has 68% water. So remaining 32% is fruit content. Weight of fresh fruits is 100 kg

Dry fruit has 20% water. So remaining 80% is fruit content. Let weight of dry fruit be y kg.

Fruit % in fresh fruit = Fruit% in dry fruit

So $\dfrac{32}{100} \times 100 = \dfrac{80}{100} \times y$

We get, $y = 40$ kg

35. (c)

Let x be the maximum marks,

Then (25% of x) + 30 = (50% of x) − 20

$$\frac{x}{4} + 30 = \frac{x}{2} - 20$$

So $2x - x = 120 + 80$

Hence $x = 200$

Hence maximum marks = 200

The minimum pass marks

= 25% or 200 + 30 = 80

36. (d)

If one candidates gets 84% of votes, than the other gets 16%. Let the total number of votes be x

$\Rightarrow$ (84% − 16%) of $x = 476$

$\Rightarrow$ 68% of $x = 476$

$\Rightarrow$ $x = 700$

37. (b)

Let the salaries of A, B, C be x, $2x$ and $3x$ respectively.

Then, $2x + 3x = 6000 \Rightarrow x = 1200$

A's salary = ₹ 1200, B's salary = ₹ 2400 and C's salary ₹ 3600

Excess of C's salary over A's

$$= \left[\frac{2400}{1200} \times 100\right] = 200\%$$

38. (d)

Let number of boys be 'B' and number of girls be 'G'.

Here from given data,

B + G = 1650   ...(i)

B − G = 400   ...(ii)

From (i) and (ii), we get

2B = 2050

$\Rightarrow$ B = 1025

$\Rightarrow$ G = 1650 − 1025 = 625

Hence, the % of girls = $625 \times \dfrac{100}{1650} = 37.87$

$\Rightarrow$ 38% (approx).

39. (a)

Let length, breadth and height of the room be 7, 3, 1 unit respectively.

Area of walls = $2(l + b) \times h$

= $2(7 + 3) \times 1 = 20$ sq. unit.

Engineering Mathematics and Numerical Analysis

2

1. Linear Algebra

Q.1 Consider the given matrix $A = \begin{bmatrix} 5 & 8 & 2 \\ 1 & 7 & 3 \\ 4 & 6 & 9 \end{bmatrix}$.

Find the principle sub-matrix of matrix A.

(a) $\begin{bmatrix} 5 & 8 \\ 1 & 7 \end{bmatrix}$
(b) $\begin{bmatrix} 8 & 2 \\ 7 & 3 \end{bmatrix}$

(c) $\begin{bmatrix} 1 & 7 \\ 4 & 6 \end{bmatrix}$
(d) None of the above

Q.2 Which of the following is a diagonal matrix?

(a) $\begin{bmatrix} 1 & 0 & 0 \\ 5 & 2 & 0 \\ 6 & 8 & 3 \end{bmatrix}$
(b) $\begin{bmatrix} 1 & 3 & 6 \\ 0 & 1 & 4 \\ 0 & 0 & 1 \end{bmatrix}$

(c) $\begin{bmatrix} 3 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 9 \end{bmatrix}$
(d) $\begin{bmatrix} 0 & 8 & 4 \\ 5 & 0 & 3 \\ 6 & 7 & 1 \end{bmatrix}$

Q.3 Which of the following is a scalar matrix?

(a) $\begin{bmatrix} 1 & 2 & 2 \\ 3 & 1 & 2 \\ 3 & 3 & 1 \end{bmatrix}$
(b) $\begin{bmatrix} 4 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}$

(c) $\begin{bmatrix} 3 & 1 & 2 \\ 0 & 3 & 4 \\ 0 & 0 & 3 \end{bmatrix}$
(d) $\begin{bmatrix} 6 & 0 & 0 \\ 5 & 6 & 0 \\ 3 & 2 & 6 \end{bmatrix}$

Q.4 $\begin{bmatrix} \sin(x+p) & \sin(x+q) & \sin(x+r) \\ \sin(y+p) & \sin(y+q) & \sin(y+r) \\ \sin(z+p) & \sin(z+q) & \sin(z+r) \end{bmatrix} = \ .....$

(a) $\sin(x+y+z)$
(b) $\sin(p+q+r)$
(c) 0
(d) 1

Q.5 Consider the following matrixes and select the Idempotent matrix.

(a) $\begin{bmatrix} 1 & 0 & -4 \\ 4 & 2 & 5 \\ -4 & 3 & -3 \end{bmatrix}$
(b) $\begin{bmatrix} 1 & -4 & -5 \\ 3 & -2 & 1 \\ 6 & 4 & 5 \end{bmatrix}$

(c) $\begin{bmatrix} 2 & -2 & -4 \\ -1 & 3 & 4 \\ 1 & -2 & -3 \end{bmatrix}$
(d) $\begin{bmatrix} 3 & -5 & 4 \\ -1 & 2 & 5 \\ -4 & -2 & -6 \end{bmatrix}$

Q.6 If $\begin{vmatrix} 3x-8 & 3 & 3 \\ 3 & 3x-8 & 3 \\ 3 & 3 & 3x-8 \end{vmatrix} = 0$, then $x = ?$

(a) $\dfrac{3}{2}, \dfrac{3}{11}$
(b) $\dfrac{3}{2}, \dfrac{11}{3}$

(c) $\dfrac{2}{3}, \dfrac{11}{3}$
(d) $\dfrac{2}{3}, \dfrac{3}{11}$

Q.7 Which of the following matrix is an involutory matrix?

(a) $\begin{bmatrix} 4 & 3 & 3 \\ -1 & 0 & -1 \\ -4 & -4 & -3 \end{bmatrix}$
(b) $\begin{bmatrix} 2 & -1 & -2 \\ -4 & 0 & 3 \\ 4 & 1 & 3 \end{bmatrix}$

(c) $\begin{bmatrix} 4 & 2 & -4 \\ 1 & 0 & -5 \\ 3 & -6 & 6 \end{bmatrix}$
(d) $\begin{bmatrix} 5 & 6 & -5 \\ 4 & 0 & -4 \\ -3 & 2 & 3 \end{bmatrix}$

Q.8 Considering the following statements in relation to addition of matrices :
1. Matrix addition is commutative
2. Matrix addition is associative
Which of the following is correct:
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q.9 Consider the following statements in relation to multiplication of matrices :
1. Multiplication of matrices is commutative.
2. Matrix multiplication is associative, if compatibility is assured.
3. Multiplication of matrices is distributive with respect to addition of matrices.
Which of the above is/are correct?
(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Q.10 Consider the following two statements :

1. The maximum number of linearly independent column vectors of a matrix A is called the rank of A.

2. If A is an $n \times n$ square matrix, if will be non-singular if rank $A = n$.

With reference to the above statements, which of the following applies?

(a) Both the statements are true.

(b) Both the statements are false.

(c) 1 is true but 2 is false.

(d) 1 is false but 2 is true.

Q.11 Which of the following is correct in relation to skew-symmetric matrix?

(a) It must have all 1's in the diagonal.

(b) It must have all 0's in the diagonal.

(c) It must have all of diagonal elements equal to 1.

(d) It must have all of diagonal elements equal to 0.

Q.12 If $A = \begin{bmatrix} 2 & -2 & -4 \\ -1 & 3 & 4 \\ 1 & -2 & P \end{bmatrix}$ is an idempotent matrix, then P is equal to

(a) −1   (b) −5

(c) −4   (d) −3

Q.13 If a matrix $A = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ then A^{2017} will be

(a) $2^{2016} A$ (b) $2^{1008} A$

(c) $-2^{2017} A$ (d) I

Q.14 If a matrix $B = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ then B^{2017} will be

(a) $3^{2017} B$ (b) $-3^{2017} B$

(c) $3^{2016} B$ (d) $3^{1008} B$

Q.15 Consider the following statements and find the incorrect statement about properties of determinants:

(a) The value of a determinant does not change when rows and columns are interchanged.

(b) The value of a determinant also does not change when any two rows or two columns of a determinant are interchanged.

(c) If any two rows of a determinant are identical, then $|A| = 0$

(d) If A be n-rowed square matrix, and K be any scalar then $|KA| = K^n |A|$

Q.16 Which of the following statement is incorrect about rank of a matrix?

(a) It is defined as the size of the largest non-zero minor.

(b) Rank of matrix is the number of non-zero rows in its echelon form.

(c) For any matrix A or order $(m \times n)$, rank $(A) \le \max (m, n)$.

(d) Only null matrix can have a rank of zero. All other matrices have rank of atleast one.

Q.17 If $A = \begin{bmatrix} x & 0 \\ 1 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 \\ 5 & 1 \end{bmatrix}$ then $A^2 = B$ for

(a) $x = 4$ (b) $x = 1$

(c) $x = -1$ (d) None of these

Q.18 Match the following columns:

Column (I)

1. A is a square matrix such that $A^2 = A$.

2. A is a square matrix such that $A^m = 0$.

3. A is a square matrix such that $A^2 = I$.

4. A is a square matrix such that $A^T = A$.

Column (II)

P. A is a symmetric matrix.

Q. A is a Nilpotent matrix.

R. A is an idempotent matrix.

S. A is an involutary matrix.

(a) 1 − R, 2 − Q, 3 − S, 4 − P

(b) 1 − P, 2 − Q, 3 − R, 4 − S

(c) 1 − R, 2 − Q, 3 − P, 4 − S

(d) 1 − P, 2 − R, 3 − Q, 4 − S

Q.19 Which of the following statement is incorrect about rank of a matrix?

(a) Elementary transformation do not change the rank of a matrix.

(b) Rank of a product of two matrices cannot exceed the rank of either matrix i.e. $r(AB) \le r(A)$ and $r(AB) \le r(B)$.

(c) Rank of sum of two matrices cannot exceed the sum of their ranks i.e., $r(A + B) \le r(A) + r(B)$

(d) If A, B are two n-rowed square matrices then rank $(AB) \ge$ rank $(A) +$ rank $(B) + n$

Q.20 The rank of a 2×2 matrix C ($= AB$), found by multiplying a non-zero column matrix A of size 2×1 and a non-zero row matrix B of size 1×2 is
(a) 0   (b) 1
(c) 2   (d) 4

Q.21 If A and B are square matrices of size $n \times n$, then which of the following statement is incorrect?
(a) $\det(AB) = \det(A)\det(B)$
(b) $\det(KA) = K^n \det(A)$
(c) $\det(A + B) = \det(A) + \det(B)$
(d) $\det(A^T) = \dfrac{1}{\det(A^{-1})}$

Q.22 Let $A = \begin{bmatrix} 2 & 2x & x \\ 0 & x & 2x \\ 0 & 0 & 2 \end{bmatrix}$, if $\det(A^2) = 4$ then (x) is
(a) 1   (b) 2
(c) $\dfrac{1}{2}$ (d) 4

Q.23 If $1, \omega, \omega^2$ are cube roots of unity, then
$$\begin{vmatrix} a & a^2 & a^3 - 1 \\ a^\omega & a^{2\omega} & a^{3\omega} - 1 \\ a^{\omega^2} & a^{2\omega^2} & a^{3\omega^2} - 1 \end{vmatrix} = \dots\dots$$
(a) 0   (b) a
(c) a^2 (d) a^3

Q.24 Consider the following statements in relations to orthonormal condition of vectors.
1. Vectors should be orthogonal
2. Each vector has unit length.
Which of the following is correct:
(a) 1 only   (b) 2 only
(c) Both 1 and 2   (d) Neither 1 nor 2

Q.25 The value of α, β, γ when $A = \begin{bmatrix} 0 & 2\beta & \gamma \\ \alpha & \beta & -\gamma \\ \alpha & -\beta & \gamma \end{bmatrix}$ is orthogonal are $\dots\dots$
(a) $\pm\dfrac{1}{\sqrt{2}}, \pm\dfrac{1}{\sqrt{6}}, \pm\dfrac{1}{\sqrt{2}}$ (b) $\pm\dfrac{1}{\sqrt{3}}, \pm\dfrac{1}{\sqrt{2}}, \pm\dfrac{1}{\sqrt{6}}$
(c) $\pm\dfrac{1}{\sqrt{2}}, \pm\dfrac{1}{\sqrt{6}}, \pm\dfrac{1}{\sqrt{3}}$ (d) $\pm\dfrac{1}{\sqrt{2}}, \pm\dfrac{1}{\sqrt{2}}, \pm\dfrac{1}{\sqrt{2}}$

Q.26 Investigate the values α and β for the given
$$x + 2y + 3z = 6$$
$$x + 3y + 5z = 9$$
$$2x + 5y + \alpha z = \beta$$
and correct match the following columns.

Column I	Column II
1. $\alpha = 8, \beta \neq 15$	A. Infinity Solutions
2. $\alpha \neq 8, \beta \in R$	B. No solutions
3. $\alpha = 8, \beta = 15$	C. Unique solutions

(a) 1–A, 2–B, 3–C
(b) 1–B, 2–C, 3–A
(c) 1–C, 2–A, 3–B
(d) 1–C, 2–B, 3–A

Q.27 If $A = \begin{bmatrix} -2 & 3 \\ -1 & 1 \end{bmatrix}$, then $A^3 = \dots.$
(a) I (b) 0
(c) $-A$ (d) $A + I$

Q.28 If $A = \begin{bmatrix} 1 & 3 \\ 4 & 2 \end{bmatrix}$ then $I + A + A^2 + \dots\dots \infty = \dots\dots$
(a) $\dfrac{1}{6}\begin{bmatrix} -1 & 3 \\ 4 & 0 \end{bmatrix}$ (b) $\dfrac{1}{12}\begin{bmatrix} -1 & 3 \\ 4 & 0 \end{bmatrix}$
(c) $\dfrac{1}{6}\begin{bmatrix} -1 & 4 \\ 3 & 0 \end{bmatrix}$ (d) $\dfrac{1}{12}\begin{bmatrix} -1 & 4 \\ 3 & 0 \end{bmatrix}$

Q.29 If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ then $8A^{-4} = \dots.$
(a) $145A^{-1} - 27\,I$ (b) $27I - 145\,A^{-1}$
(c) $29A^{-1} + 9I$ (d) $145\,A^{-1} + 27I$

Q.30 If $A = \begin{bmatrix} 1 & 2 \\ -2 & -1 \end{bmatrix}$ and $\phi(x) = (1 + x)(1 - x)^{-1}$ then $\phi(A) = \dots.$
(a) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix}$
(c) $\begin{bmatrix} 1 & 1 \\ -1 & 0 \end{bmatrix}$ (d) $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

Q.31 If $A = \begin{bmatrix} 1 & 0 \\ -1 & 7 \end{bmatrix}$ and $A^2 = 8A + kI_2$, then $k = \dots.$
(a) I (b) -1
(c) 7   (d) -7

Answer Key : Engineering Mathematics and Numerical Analysis

1. (a)	2. (c)	3. (b)	4. (c)	5. (c)	6. (c)	7. (a)	8. (c)
9. (c)	10. (a)	11. (b)	12. (d)	13. (a)	14. (c)	15. (b)	16. (c)
17. (d)	18. (a)	19. (d)	20. (b)	21. (c)	22. (c)	23. (a)	24. (c)
25. (c)	26. (b)	27. (a)	28. (b)	29. (b)	30. (b)	31. (d)	32. (a)
33. (c)	34. (c)	35. (d)	36. (c)	37. (a)	38. (b)	39. (c)	40. (d)
41. (a)	42. (b)	43. (a)	44. (c)	45. (c)	46. (b)	47. (d)	48. (b)
49. (c)	50. (d)	51. (b)	52. (a)	53. (d)	54. (d)	55. (c)	56. (b)
57. (b)	58. (b)	59. (b)	60. (d)	61. (d)	62. (b)	63. (b)	64. (a)
65. (a)	66. (d)	67. (c)	68. (a)	69. (d)	70. (a)	71. (d)	72. (b)
73. (d)	74. (c)	75. (c)	76. (a)	77. (b)	78. (b)	79. (d)	80. (c)
81. (c)	82. (c)	83. (b)	84. (c)	85. (b)	86. (c)	87. (a)	88. (d)
89. (a)	90. (c)	91. (a)	92. (d)	93. (a)	94. (c)	95. (b)	96. (b)
97. (b)	98. (b)	99. (c)	100. (c)	101. (d)	102. (a)	103. (d)	104. (a)
105. (c)	106. (b)	107. (b)	108. (b)	109. (a)	110. (a)	111. (b)	112. (a)
113. (c)	114. (a)	115. (c)	116. (a)	117. (a)	118. (a)	119. (a)	120. (b)
121. (a)	122. (a)	123. (c)	124. (a)	125. (b)	126. (a)	127. (a)	128. (a)
129. (a)	130. (a)	131. (a)	132. (b)	133. (d)	134. (b)	135. (a)	136. (d)
137. (d)	138. (c)	139. (a)	140. (b)	141. (b)	142. (a)	143. (a)	144. (d)
145. (d)	146. (a)	147. (a)	148. (b)	149. (d)	150. (b)	151. (d)	152. (d)
153. (b)	154. (a)	155. (b)	156. (b)	157. (c)	158. (b)	159. (a)	160. (d)
161. (a)	162. (a)	163. (b)	164. (b)	165. (c)	166. (a)	167. (c)	168. (a)
169. (c)	170. (a)	171. (a)	172. (c)	173. (c)	174. (b)	175. (c)	176. (a)
177. (a)	178. (d)	179. (b)	180. (b)	181. (a)	182. (d)	183. (c)	184. (b)
185. (a)	186. (a)	187. (c)	188. (b)	189. (d)	190. (a)	191. (c)	192. (c)
193. (b)	194. (a, b)	195. (b)	196. (c)	197. (a)	198. (b)	199. (b)	200. (b)
201. (b)	202. (d)	203. (d)	204. (a)	205. (c)	206. (b)	207. (a)	208. (a)
209. (c)	210. (b)	211. (b)	212. (d)	213. (c)	214. (c)	215. (d)	216. (a)
217. (b)	218. (d)	219. (c)	220. (a)	221. (a)	222. (b)	223. (b)	224. (d)
225. (b)	226. (c)	227. (a)	228. (d)	229. (d)	230. (a)	231. (d)	232. (a)
233. (d)	234. (d)	235. (c)	236. (a)	237. (d)	238. (c)	239. (c)	240. (a)

Explanations : Engineering Mathematics and Numerical Analysis

1. (a)
Principle sub-matrix of a matrix A has same diagonal elements as the diagonal elements of the matrix A.

So correct option is $\begin{bmatrix} 5 & 8 \\ 1 & 7 \end{bmatrix}$.

2. (c)
A square matrix in which all off-diagonal elements are zero is called a diagonal matrix.

3. (b)
A scalar matrix is a diagonal matrix with all diagonal elements being equal.

4. (c)
Given matrix is a product of two matrix

$$= \begin{bmatrix} \sin x & \cos x & 0 \\ \sin y & \cos y & 0 \\ \sin z & \cos z & 0 \end{bmatrix} \times \begin{bmatrix} \cos p & \cos q & \cos r \\ \sin p & \sin q & \sin r \\ 0 & 0 & 0 \end{bmatrix}$$

$= 0 \times 0 = 0$

5. (c)
A matrix A is called idempotent iff $A^2 = A$.

By considering above matrix only $\begin{bmatrix} 2 & -2 & -4 \\ -1 & 3 & 4 \\ 1 & -2 & -3 \end{bmatrix}$

satisfies the condition of being idempotent.

6. (c)
Performing operation column (1) $\rightarrow$ column (1) + (2) + (3)

$$\begin{vmatrix} 3x-2 & 3 & 3 \\ 3x-2 & 3x-8 & 3 \\ 3x-2 & 3 & 3x-8 \end{vmatrix} = 0$$

$$\Rightarrow \quad (3x-2)\begin{vmatrix} 1 & 3 & 3 \\ 1 & 3x-8 & 3 \\ 1 & 3 & 3x-8 \end{vmatrix} = 0$$

Now expanding along R_1

$\Rightarrow$ $(3x-2)\,[1\{(3x-8)^2-9\}-3\{(3x-8)-3\}+3\{3-(3x-8)\}] = 0$

$\Rightarrow$ $(3x-2)[(3x-8)^2-9-3(3x-8)+9+9-3(3x-8)] = 0$

On solving we get $\quad (3x-2)(3x-11)^2 = 0$

So, $\quad x = \dfrac{2}{3}, \dfrac{11}{3}$

7. (a)
A matrix A is called involutory iff $A^2 = I$.
By considering above matrix only (a) satisfy the condition.

$$\Rightarrow \begin{bmatrix} 4 & 3 & 3 \\ -1 & 0 & -1 \\ -4 & -4 & -3 \end{bmatrix}\begin{bmatrix} 4 & 3 & 3 \\ -1 & 0 & -1 \\ -4 & -4 & -3 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 16-3-12 & 12-12 & 12-3-9 \\ -4+0+4 & -3+0+4 & -3+0+3 \\ -16+4+12 & -12+0+12 & -12+4+9 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = I$$

8. (c)
Matrix addition is commutative $A + B = B + A$
Matrix addition is associative $(A + B) + C$
$\qquad = A + (B + C)$

9. (c)
Multiplication of matrices is not commutative. In fact, if the product of AB exists, then it is not necessary that the product of BA will also exist. So statement (1) is correct.
Statement (2) is correct i.e., $A(BC) = (AB)C$ because if was mentioned in the statement that if conformability is assured.
Statement (3) is correct i.e. $A(B + C) = AB + AC$.

11. (b)
Only (b) option is must others are not the mandatory criteria.
For skew-symmetric matrix $(A^T = -A)$

12. (d)
For idempotent matrix $A^2 = A$

$$\therefore \quad \begin{bmatrix} 2 & -2 & -4 \\ -1 & 3 & 4 \\ 1 & -2 & P \end{bmatrix} \times \begin{bmatrix} 2 & -2 & -4 \\ -1 & 3 & 4 \\ 1 & -2 & P \end{bmatrix}$$

$$= \begin{bmatrix} 2 & -2 & -4 \\ -1 & 3 & 4 \\ 1 & -2 & P \end{bmatrix}$$

On multiplying we get

$$\begin{bmatrix} 2 & -2 & -16-4P \\ -1 & 3 & 16+4P \\ 4+P & -8-2P & -12+P^2 \end{bmatrix} = \begin{bmatrix} 2 & -2 & -4 \\ -1 & 3 & 4 \\ 1 & -2 & P \end{bmatrix}$$

By comparing component we have

$$-16-4P = -4$$
$$4+P = 1$$
$$P = -3$$

13. (a)

$$\because A^2 = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} 2 & 2 \\ 2 & 2 \end{bmatrix} = 2 \times \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} = 2A$$

Now $A^3 = A \cdot A^2 = A \cdot 2A = 2A^2$
$$= 2(2A) = 2^2A = 2^{3-1}A$$

Similarly $A^{2017} = 2^{2017-1}A = 2^{2016}A$

14. (c)

$$\because \qquad B^2 = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 3 & 3 & 3 \\ 3 & 3 & 3 \\ 3 & 3 & 3 \end{bmatrix}$$

$$= 3 \times \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} = 3B$$

So $\quad B^3 = B \cdot B^2 = B \cdot (3B)$
$$= 3B^2 = 3(3B) = 3^2B = 3^{3-1}B$$

So $\quad B^{2017} = 3^{2017-1}B = 3^{2016}B$

15. (b)

If any two rows or two columns of a determinant are interchanged the value of determinant is multiplied by –1.

16. (c)

For any matrix $A_{(m \times n)}$, rank $(A) \le \min (m, n)$
i.e. maximum rank of $A_{m \times n} = \min(m, n)$

17. (d)

$$\begin{bmatrix} x & 0 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} x & 0 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 5 & 1 \end{bmatrix} \qquad \because \quad (A^2 = B) \text{ given}$$

$$\Rightarrow \begin{bmatrix} x^2 & 0 \\ x+1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 5 & 1 \end{bmatrix}$$

$$\Rightarrow \qquad x^2 = 1 \qquad\qquad\qquad ...(1)$$
and $\qquad x + 1 = 5 \qquad\qquad\qquad ...(2)$

Hence there is no x given in option that satisfies the above two equations. So option (d) is correct.

19. (d)

Last option is incorrect because Rank $(AB) \ge$ Rank $(A) +$ Rank $(B) - n$

20. (b)

Let $\qquad A = \begin{bmatrix} a_1 \\ b_1 \end{bmatrix}$ and $B = \begin{bmatrix} a_2 & b_2 \end{bmatrix}$

So, $\qquad C = AB = \begin{bmatrix} a_1 \\ b_1 \end{bmatrix}\begin{bmatrix} a_2 & b_2 \end{bmatrix}$

$$= \begin{bmatrix} a_1a_2 & a_1b_2 \\ b_1a_2 & b_1b_2 \end{bmatrix}$$

But we know that rank $C (= AB) \le \min \{$rank A, rank $B\}$
So rank of C will be equal to 1.

21. (c)

It is not necessary that sum of determinant of two matrix A and B will be equal to the determinant of a matrix obtained by adding then two matrices A and B.

22. (c)

$$\det (A^2) = [\det(A)]^2 = \begin{vmatrix} 2 & 2x & x \\ 0 & x & 2x \\ 0 & 0 & 2 \end{vmatrix}^2 = 4$$

$$\Rightarrow \quad [2(2x)]^2 = 4 \quad \Rightarrow \quad x^2 = \frac{1}{4} \quad \Rightarrow \quad |x| = \frac{1}{2}$$

23. (a)

The above matrix can be written as

$$= \begin{vmatrix} a & a^2 & a^3 \\ a^\omega & a^{2\omega} & a^{3\omega} \\ a^{\omega^2} & a^{2\omega^2} & a^{3\omega^2} \end{vmatrix} - \begin{vmatrix} a & a^2 & 1 \\ a^\omega & a^{2\omega} & 1 \\ a^{\omega^2} & a^{2\omega^2} & 1 \end{vmatrix}$$

$$= a \cdot a^\omega \cdot a^{\omega^2}\begin{vmatrix} 1 & a & a^2 \\ 1 & a^\omega & a^{2\omega} \\ 1 & a^{\omega^2} & a^{3\omega} \end{vmatrix} + \begin{vmatrix} 1 & a^2 & a \\ 1 & a^{2\omega} & a^\omega \\ 1 & a^{3\omega} & a^{\omega^2} \end{vmatrix}$$

interchanging C_1 and C_3 in 2nd matrix
$\therefore$ Given $\quad 1 + \omega + \omega^2 = 0$

So $\Rightarrow \quad a^{(1+\omega+\omega^2)}$ term will be $a^0 = 1$ and

$$\Rightarrow \begin{vmatrix} 1 & a & a^2 \\ 1 & a^\omega & a^{2\omega} \\ 1 & a^{\omega^2} & a^{2\omega^2} \end{vmatrix} - \begin{vmatrix} 1 & a & a^2 \\ 1 & a^\omega & a^{2\omega} \\ 1 & a^{\omega^2} & a^{2\omega^2} \end{vmatrix}$$

$\Rightarrow \quad 0 \quad$ (interchanging C_2 and C_3 in 2nd matrix)

General Principles of Design, Drawing, Importance of Safety

1. Engineering Design Process

Q.1 Which of the following involves least fraction of cost to produce a product?
(a) Product design   (b) Manufacturing
(c) Marketing   (d) Material

Q.2 Which from of design deals with improving the appeal of a product to the human senses?
(a) Innovative design
(b) Adaptive design
(c) Selective design
(d) Industrial design

Q.3 Which step in engineering design process involves decision making?
(a) Define problem
(b) Gather information
(c) Concept generation
(d) Evaluation

Q.4 Which phase of the design includes modelling and simulation?
(a) Product architecture
(b) Configuration design
(c) Parametric design
(d) Detail design

Q.5 Which of the following is/are true about parametric design of parts?
1. Aim to establish exact dimensions and tolerances.
2. To examine the part, assembly and system for design robustness.
3. Determining the aspects of design that could lead to failure.
4. Design to enhance the manufacturing.
(a) 1 only   (b) 2 only
(c) 1, 2, 3 only   (d) 1, 2, 3, 4

Q.6 Planning for manufacture includes following tasks
1. Detailed engineering drawing suitable for manufacturing.
2. Designing specialized tools and fixtures.
3. Planning work schedule and inventory control.
4. Planning quality assurance system.

5. Establishing standard time and labour cost.
(a) 1, 2, 3, 4 only   (b) 2, 3, 4, 5 only
(c) 1, 2, 3, 5 only   (d) 1, 2, 3, 4, 5

Q.7 Which of the following statements are true about sequential engineering?
1. Each stage of development process is carried out separately.
2. Next stage can't start until the previous stage is finished.
3. Information flow is only in one direction.
4. Reduced product development cost.
5. This method is hardly used today.
(a) 1, 2, 3 only
(b) 1, 2, 3, 4 only
(c) 1, 2, 3, 5 only
(d) 1, 2, 3, 4, 5

Q.8 Which of the following are true about concurrent engineering?
1. It is more efficient than sequential engineering.
2. It brings together multidisciplinary teams.
3. It reduces product development time and design network.
4. It reduces product development cost and improves communication.
5. Facilitated by use of computer aided engineering.
(a) 1, 2, 3 only   (b) 2, 3, 4 only
(c) 1, 3, 4, 5 only   (d) 1, 2, 3, 4, 5

Q.9 The method for generating mechanism for a machine to get a desired output for a given input is known as
(a) Analysis   (b) Innovation
(c) Synthesis   (d) Designing

Q.10 In a design process which of the following process should be followed after the selection for material
(a) Selecting factor of safety
(b) Synthesis
(c) Determining mode of failure
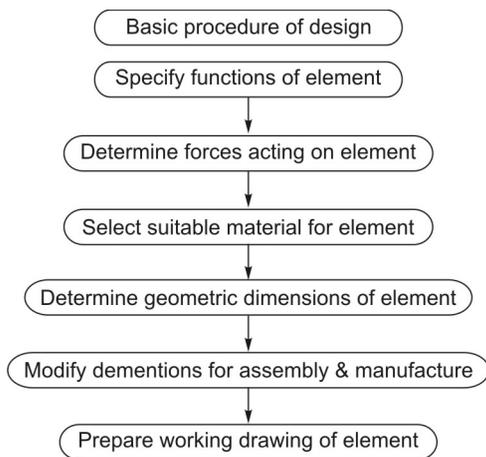(d) Analysis of forces

Q.11 The simplicity to operate and easy to understand a product is concerned with its following aspect
(a) Functional aspect
(b) Aesthetic aspect
(c) Operational aspect
(d) Durability aspect

Q.12 Which of the following is useful contributor to a strategy of mass customization?
(a) Modular design
(b) Off shoring
(c) Economics of sale
(d) Fixed automation

Q.13 One of the disadvantage of standardization is
(a) Greater customer satisfaction
(b) Interchangeability
(c) early freezing of product design
(d) Shorter product life cycle

Q.14 Which name is most closely associated with robust design?
(a) Taguchi   (b) Smith
(c) Ford   (d) McCaskey

Q.15 The term "Voice of Customer" is associated with
(a) Taguchi approach
(b) Quality function deployment
(c) Concurrent engineering
(d) Service blue printing

Q.16 Service design often differs from product design for which one of these consideration?
(a) Its life cycle
(b) Customer interference
(c) Cost and value
(d) Legal environment

Q.17 The ability of a product, part or service to perform its intended function under an appropriate set of condition is
(a) Robustness
(b) Quality
(c) Reliability
(d) Appropriateness

Q.18 Production, design and manufacturing personal being brought together early in the design process is called
(a) Reverse engineering
(b) Sequential engineering
(c) Concurrent engineering
(d) Forward engineering

Q.19 Steps involved in reverse engineering process are
(a) Documentation, observation, prediction, disassemble, analyze, test.
(b) Prediction, observation, disassemble, analyze, test, documentation.
(c) Observation, disassemble, analyze, test, prediction, documentation.
(d) Prediction, disassemble, observation, analyse, documentation, test.

Q.20 Which of the following is the preliminary stage of production planning?
(a) Capacity planning
(b) Material requirement planning
(c) Scheduling
(d) Product development and design

Q.21 Nomography stands for
(a) Graphical representation of mathematical laws
(b) Multiview of object
(c) Graphical representation of I-section
(d) Graphical representation of overlapping views

Q.22 Product design specification is done at the stage of
(a) Problem definition
(b) Generating feasible solution
(c) Synthesis
(d) Product dispatching

Q.23 Which of the following subjects is/are related to ergonomics?
(a) Anthropology
(b) Physiology
(c) Psychology
(d) All of the above

Q.24 Type of design in which a known solution is applied to satisfy a different need is called
(a) Innovative design
(b) Adaptive design
(c) Industrial design
(d) Conceptual design

Q.25 Consider the following statements regarding a Grillage Foundation:
1. It is provided for heavily loaded isolated columns.
2. It is treated as a spread foundation.
3. It consists of two sets of perpendicularly placed steel columns.

Which of the above statements are correct?
(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

[ESE Prelims 2018]

Answer Key : General Principles of Design, Drawing, Importance of Safety

1. (a)	2. (d)	3. (d)	4. (b)	5. (d)	6. (b)	7. (c)	8. (d)
9. (c)	10. (c)	11. (a)	12. (a)	13. (c)	14. (a)	15. (b)	16. (b)
17. (a)	18. (c)	19. (b)	20. (d)	21. (a)	22. (a)	23. (d)	24. (b)
25. (a)	26. (b)	27. (d)	28. (c)	29. (c)	30. (d)	31. (a)	32. (d)
33. (d)	34. (a)	35. (b)	36. (b)	37. (a)	38. (d)	39. (d)	40. (a)
41. (b)	42. (d)	43. (d)	44. (d)	45. (d)	46. (b)	47. (b)	48. (c)
49. (b)	50. (d)	51. (d)	52. (a)	53. (d)	54. (b)	55. (c)	56. (d)
57. (b)	58. (d)	59. (c)	60. (c)	61. (c)	62. (c)	63. (a)	64. (b)
65. (d)	66. (d)	67. (b)	68. (c)	69. (b)	70. (b)	71. (a)	72. (a)
73. (c)	74. (c)	75. (d)	76. (a)	77. (d)	78. (c)	79. (d)	80. (b)
81. (c)	82. (a)	83. (a)	84. (d)	85. (c)	86. (d)	87. (a)	88. (a)
89. (a)	90. (a)	91. (c)	92. (d)	93. (b)	94. (d)	95. (b)	96. (a)
97. (a)	98. (a)	99. (c)	100. (c)	101. (c)	102. (d)	103. (c)	104. (b)
105. (a)	106. (b)	107. (c)	108. (b)	109. (c)	110. (a)	111. (b)	112. (c)
113. (b)	114. (c)	115. (b)	116. (a)	117. (c)	118. (a)	119. (a)	120. (c)
121. (b)	122. (b)	123. (a)	124. (c)	125. (a)	126. (a)	127. (a)	128. (a)
129. (a)	130. (a)	131. (c)	132. (c)	133. (d)	134. (c)	135. (a)	136. (c)
137. (b)	138. (a)	139. (a)	140. (b)	141. (a)	142. (a)	143. (c)	144. (b)
145. (c)	146. (c)	147. (b)	148. (c)	149. (b)	150. (a)	151. (a)	152. (d)
153. (a)	154. (c)	155. (b)	156. (a)	157. (b)	158. (b)	159. (b)	160. (c)
161. (c)	162. (c)	163. (d)	164. (b)	165. (b)	166. (d)	167. (b)	168. (a)
169. (a)	170. (a)	171. (b)	172. (d)	173. (b)	174. (c)	175. (b)	176. (b)
177. (c)	178. (c)	179. (d)	180. (d)	181. (d)	182. (a)	183. (c)	184. (d)
185. (b)	186. (d)	187. (d)	188. (b)	189. (b)	190. (d)	191. (a)	192. (d)
193. (a)	194. (a)	195. (a)	196. (c)	197. (a)	198. (a)	199. (b)	200. (a)
201. (b)	202. (c)	203. (c)	204. (c)	205. (d)	206. (a)	207. (c)	208. (b)
209. (a)	210. (b)	211. (b)	212. (d)	213. (d)	214. (d)	215. (d)	216. (b)
217. (c)	218. (d)	219. (c)	220. (b)	221. (b)	222. (b)	223. (b)	224. (a)
225. (d)	226. (b)	227. (b)	228. (b)	229. (c)	230. (c)	231. (d)	232. (c)
233. (d)	234. (d)	235. (c)	236. (a)	237. (d)	238. (b)	239. (b)	240. (c)
241. (b)	242. (b)	243. (c)	244. (a)	245. (c)	246. (c)	247. (b)	248. (b)
249. (d)	250. (c)	251. (b)	252. (a)	253. (d)	254. (b)	255. (c)	256. (d)
257. (d)	258. (c)	259. (a)	260. (a)	261. (b)	262. (b)	263. (d)	264. (b)

Explanations : General Principles of Design, Drawing, Importance of Safety

1. (a) Product design costs around 5% in general, of the total product cost.

6. (b) Detailed engineering drawing is part of detail design.

7. (c) Since, the information flow is only in one direction and it is not until the end of the chain that occurs changes and connections can be relayed to the start of the sequence, causing estimated cost to be under predicted.

10. (c)

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┌────────────────────────────────┐
│    Basic procedure of design    │
└────────────────────────────────┘
┌────────────────────────────────┐
│   Specify functions of element  │
└────────────────────────────────┘
              ↓
┌────────────────────────────────┐
│ Determine forces acting on element │
└────────────────────────────────┘
              ↓
┌────────────────────────────────┐
│  Select suitable material for element │
└────────────────────────────────┘
              ↓
┌────────────────────────────────┐
│ Determine geometric dimensions of element │
└────────────────────────────────┘
              ↓
┌────────────────────────────────┐
│ Modify dementions for assembly & manufacture │
└────────────────────────────────┘
              ↓
┌────────────────────────────────┐
│ Prepare working drawing of element │
└────────────────────────────────┘
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12. (a) Modular design is a design approach that subdivides a system into smaller parts that can be independently created and then used in different systems. This allows designs to be customized, upgraded, repaired and for parts to be reused.

23. (d) Anthropology is the study of various aspects of human within past and present societies.

24. (b) In adaptive design, the designer applied a known solution to satisfy a different need.

28. (c) Serviceability is an expression of the ease with which a component, device or system can be maintained and repaired.

30. (d) Option (a): Internal benchmarking
Option (b): Competitive benchmarking
Option (c): Functional benchmarking
Option (d): Generic benchmarking

35. (b) The product planning phase of quality function deployment is house of quality.

37. (a) Quality function deployment arms at satisfying customer needs.

45. (d) Expecters: Basic attributes that one would expect to seen in the product.

Spoken: Specific features that customers say they want in product.

Unspoken: Product attributes that the customers does not generally talk about, but they remain important to him or her.

Exciters: Product features that make it unique and distinguish from the competition. Absence of these features will not make customer unhappy, since they do not know that is missing.

47. (b) Emotional block: Obstacles connected with the psychological safety of the individual like fear or risk taking, motivation.

Intellectual block: Arises from a poor choice of the problem solving strategy, insufficient knowledge base.

Environmental block: Arises from immediate physical environment or social environment, criticism.

Cultural block: Set of thought pattern from living in a culture.

48. (c) Brain writing is a variation of brain storming which involves writing down as many ideas as possible. When time period elapsed, member share their ideas.

54. (b) Inversion is basically getting the solution by using the different parameter variation and some cons variable.

55. (c) Decision under certainty: Each action results in known outcome with probability 1.

Decision under uncertainty: Each outcome has an assigned probability of occurrence.

Decision under risk: Each action results in multiple outcomes, with probability unknown.

Decision under conflict: Outcomes are replaced by course of action determined by opponent who is trying to maximize his/her objective function.