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PULEET Sample Paper 2027

Panjab University Lateral Engineering Entrance Test (diploma to 2nd-year B.E.) · Practice Paper 1

Questions	Marks	Time	Negative marking
100 MCQs	**100**	**1 hour 40 minutes**	**1/4 per wrong answer**

Part	Section	Questions	Q. No.
Part I – General Engineering	Basic Electrical Engineering	10	1 to 10
Part I – General Engineering	Basic Electronics	10	11 to 20
Part I – General Engineering	Programming Fundamentals	10	21 to 30
Part I – General Engineering	Fundamentals of Mechanical Engineering	10	31 to 40
Part I – General Engineering	Fundamentals of Civil Engineering	10	41 to 50
Part I – General Engineering	Fundamentals of Chemical Engineering	10	51 to 60
Part II	Physics	10	61 to 70
Part III	Chemistry	10	71 to 80
Part IV	Mathematics	10	81 to 90
Part V	General Aptitude and Communication Skills	10	91 to 100

Instructions

1. There are 100 multiple-choice questions in ten sections of 10 questions each: six General Engineering sections, then Physics, Chemistry, Mathematics, and General Aptitude and Communication Skills.
2. All sections are compulsory for every candidate, whatever the diploma branch. Each question has four options (A, B, C, D); choose the one correct answer.
3. Each correct answer carries 1 mark and 1/4 mark is deducted for each wrong answer. Unattempted questions get 0.
4. Attempt the paper in one sitting of 1 hour 40 minutes, as in the real OMR test. Calculators are not allowed.
5. The paper is in English only, as in the real PULEET. The answer key and solutions are at the end.

This is an AglaSem practice paper written on the official PULEET pattern (100 MCQs, 1 hour 40 minutes, 1/4 negative marking) and the syllabus in the Panjab University PULEET prospectus. It is not an official Panjab University paper, and its questions are original.

Part I – General Engineering

Basic Electrical Engineering

1. Three equal resistors of 9 Ω each are connected in delta. The resistance of each arm of the equivalent star is:

(A) 27 Ω (B) 3 Ω
(C) 4.5 Ω (D) 9 Ω

2. A 10 V source with a 5 Ω series resistance is converted into its Norton equivalent. The Norton equivalent is:

(A) 50 A and 5 Ω in parallel (B) 0.5 A and 5 Ω in parallel
(C) 2 A and 5 Ω in parallel (D) 2 A and 5 Ω in series

3. The time constant of a series RC circuit with R = 10 kΩ and C = 100 μF is:

(A) 0.1 s (B) 10 s

(C) 1 s (D) 5 s

4. The RMS value of a sinusoidal voltage with a peak value of 325 V is about:

(A) 460 V (B) 207 V

(C) 325 V (D) 230 V

5. In a balanced delta-connected load, the phase current is 10 A. The line current is about:

(A) 10 A (B) 5.77 A

(C) 30 A (D) 17.3 A

6. In a magnetic circuit, the quantity analogous to resistance in an electric circuit is:

(A) Magnetomotive force (B) Permeance

(C) Reluctance (D) Magnetic flux

7. A single-phase transformer has 2000 primary turns and 200 secondary turns. If the primary is connected to 230 V, the secondary voltage is:

(A) 23 V (B) 115 V

(C) 2300 V (D) 46 V

8. A transformer has a full-load copper loss of 400 W and an iron loss of 100 W. Its efficiency is maximum at:

(A) Twice full load (B) One-fourth of full load

(C) Half of full load (D) Full load

9. A 220 V DC shunt motor draws an armature current of 10 A. If the armature resistance is 0.5 Ω, the back EMF is:

(A) 225 V (B) 215 V

(C) 210 V (D) 220 V

10. A stepper motor has a step angle of 1.8°. The number of steps it takes to complete one revolution is:

(A) 200 (B) 360

(C) 180 (D) 100

Basic Electronics

11. A varactor diode is used mainly as a:

(A) Voltage regulator (B) Variable capacitor

(C) Rectifier for high current (D) Light emitter

12. The maximum theoretical efficiency of a half-wave rectifier is:

(A) 40.6% (B) 81.2%

(C) 100% (D) 50%

13. In a common-emitter transistor amplifier, the base current is 20 μA and β = 100. The collector current is:

(A) 20 mA (B) 2 A

(C) 0.2 mA (D) 2 mA

14. An inverting op-amp amplifier has R_f = 100 kΩ and R_1 = 10 kΩ. Its voltage gain is:

(A) −10 (B) +11

(C) −11 (D) +10

15. According to the Barkhausen criterion, sustained oscillations need a loop gain Aβ of:

(A) Less than one, with zero phase shift

(B) Zero, with any phase shift

(C) Unity, with zero net phase shift

(D) Unity, with a 180° phase shift

16. Which of the following is a universal logic gate?

(A) AND (B) NOR

(C) XOR (D) OR

17. The Boolean expression A + AB simplifies to:

(A) A (B) B

(C) AB (D) A + B

18. The number of select lines needed for an 8-to-1 multiplexer is:

(A) 3 (B) 2

(C) 4 (D) 8

19. Which of the following transducers generates its own output voltage (an active transducer)?

(A) Thermistor (B) Strain gauge

(C) LVDT (D) Thermocouple

20. In amplitude modulation with a modulation index of 1, the total transmitted power is how many times the carrier power?

(A) 2 (B) 1

(C) 1.5 (D) 0.5

Programming Fundamentals

21. Which memory in a computer has the shortest access time?

(A) Hard disk (B) Main memory (RAM)

(C) Cache memory (D) CPU registers

22. Which Linux command prints the full path of the current working directory?

(A) pwd (B) cd

(C) dir (D) ls

23. What does the following C code print?

```
int a = 7, b = 2;
printf("%d", a / b);
```

(A) 3 (B) 3.0

(C) 3.5 (D) 4

24. After the following C statements execute, what are the values of a and b?

```
int a = 5, b;
b = a++ * 2;
```

(A) a = 6, b = 12 (B) a = 6, b = 10

(C) a = 5, b = 10 (D) a = 5, b = 12

25. What is the value of the C expression 12 >> 2?

(A) 10 (B) 3

(C) 48 (D) 6

26. How many times is the body of this loop executed?

```
for (i = 0; i < 10; i += 3)
    printf("*");
```

(A) 10
(B) 3
(C) 5
(D) 4

27. What does this code print?

```
int a[] = {10, 20, 30, 40};
int *p = a;
printf("%d", *(p + 2));
```

(A) 12
(B) 30
(C) 20
(D) 40

28. For the recursive function below, what does f(4) return?

```
int f(int n) {
    if (n == 0) return 0;
    return n + f(n - 1);
}
```

(A) 4
(B) 0
(C) 10
(D) 24

29. In C, the memory allocated to a union is equal to:

(A) The size of its first member
(B) The sum of the sizes of all its members
(C) The size of its smallest member
(D) The size of its largest member

30. In object-oriented programming, binding data and the functions that work on it into a single unit is called:

(A) Inheritance
(B) Polymorphism
(C) Data abstraction
(D) Encapsulation

Fundamentals of Mechanical Engineering

31. The Kelvin–Planck statement of the second law says that no heat engine working in a cycle can:

(A) Work between a hot reservoir and a cold reservoir
(B) Have an efficiency greater than zero in practice
(C) Transfer heat from a colder body to a hotter body by itself
(D) Turn all the heat from a single reservoir into work

32. A refrigerator works on a reversed Carnot cycle between 250 K and 300 K. Its coefficient of performance is:

(A) 1.2
(B) 0.83
(C) 6
(D) 5

33. A sample of wet steam contains 0.8 kg of dry vapour and 0.2 kg of water in suspension. Its dryness fraction is:

(A) 0.25
(B) 0.8
(C) 0.2
(D) 4

34. The air-standard efficiency of an Otto cycle with a compression ratio of 8 ($\gamma = 1.4$) is about:

(A) 56.5%
(B) 43.5%
(C) 60.0%
(D) 35.0%

35. In the air-standard Diesel cycle, heat is added at constant:

(A) Volume (B) Pressure

(C) Temperature (D) Entropy

36. Water flows through a pipe whose diameter reduces from 20 cm to 10 cm. If the velocity in the larger section is 2 m/s, the velocity in the smaller section is:

(A) 16 m/s (B) 8 m/s

(C) 4 m/s (D) 1 m/s

37. A steel bar 1 m long with a cross-section of 100 mm^2 carries an axial pull of 10 kN. If E = 200 GPa, its elongation is:

(A) 0.05 mm (B) 0.5 mm

(C) 5 mm (D) 1 mm

38. A cantilever of length L carries a point load W at its free end. The maximum bending moment is:

(A) WL, at the free end (B) WL/2, at mid-span

(C) WL, at the fixed end (D) WL/4, at the fixed end

39. A simply supported beam of span L carries a uniformly distributed load of w per unit length over the whole span. The maximum bending moment is:

(A) wL/8 (B) $wL^2/8$

(C) $wL^2/4$ (D) $wL^2/2$

40. The polar moment of inertia of a solid circular shaft of diameter d is:

(A) $\pi d^4/32$ (B) $\pi d^2/4$

(C) $\pi d^4/64$ (D) $\pi d^3/16$

Fundamentals of Civil Engineering

41. A damp-proof course (DPC) in a building is generally laid at:

(A) Plinth level (B) Lintel level

(C) Sill level (D) Roof level

42. The hydrostatic pressure at a depth of 10 m below the free surface of water is about (g = 9.81 m/s^2):

(A) 981 kPa (B) 98.1 kPa

(C) 9.81 kPa (D) 10 kPa

43. The slump test of fresh concrete is used to measure its:

(A) Durability (B) Setting time

(C) Workability (D) Compressive strength

44. In an under-reinforced RCC beam, failure starts by:

(A) Buckling of the compression steel

(B) Crushing of concrete in compression

(C) Shear failure of the support

(D) Yielding of the tension steel

45. A rolled steel I-section is designated ISMB 300. The number 300 denotes the:

(A) Weight per metre in kg (B) Depth of the section in mm

(C) Length of the beam in cm (D) Width of the flange in mm

46. A staff reading of 1.500 m is taken on a bench mark of RL 100.000 m, and the next reading of 2.000 m on point P. The reduced level of P is:

(A) 99.500 m (B) 98.500 m

(C) 101.500 m (D) 100.500 m

47. A survey line has a whole circle bearing of 240°. Its reduced (quadrantal) bearing is:

(A) S 60° E
(B) S 30° W
(C) S 60° W
(D) N 60° W

48. For a crop with a base period of 120 days, the duty of water is 1728 hectares per cumec. The delta is:

(A) 0.3 m
(B) 1.2 m
(C) 6 m
(D) 0.6 m

49. The camber given to a road surface is mainly meant for:

(A) Reducing the cost of the pavement
(B) Draining rainwater off the surface
(C) Improving the sight distance
(D) Counteracting the centrifugal force on curves

50. A soil sample has a void ratio of 0.5. Its porosity is about:

(A) 0.33
(B) 0.50
(C) 1.00
(D) 0.67

Fundamentals of Chemical Engineering

51. A temperature of 300 K is about:

(A) 572 °F
(B) 48.3 °F
(C) 26.9 °F
(D) 80.3 °F

52. The SI unit of dynamic viscosity is:

(A) kg/m^3
(B) Pa·s
(C) N/m
(D) m^2/s

53. A gas mixture contains 64 g of O_2 and 28 g of N_2. The mole fraction of oxygen is:

(A) 0.696
(B) 0.5
(C) 0.333
(D) 0.667

54. Which of the following is a unit operation (a physical change) rather than a unit process (a chemical change)?

(A) Distillation
(B) Hydrogenation
(C) Sulphonation
(D) Nitration

55. An evaporator concentrates 1000 kg/h of a 10% (by mass) salt solution to 40%. The rate of water evaporation is:

(A) 300 kg/h
(B) 600 kg/h
(C) 250 kg/h
(D) 750 kg/h

56. How much oxygen is needed to burn 24 kg of carbon completely to CO_2?

(A) 48 kg
(B) 32 kg
(C) 64 kg
(D) 88 kg

57. The number of moles of an ideal gas that occupies 24.6 L at 2 atm and 300 K is about ($R = 0.082$ L atm mol^{-1} K^{-1}):

(A) 0.5
(B) 4
(C) 1
(D) 2

58. In the van der Waals equation $(P + a/V^2)(V - b) = RT$ for one mole, the constant 'a' corrects for:

(A) The mass of the molecules

(B) The finite volume of the molecules

(C) Attraction between the molecules

(D) Collisions with the container wall

59. The Clausius–Clapeyron equation relates:

(A) Solubility of a gas to its partial pressure

(B) Density of a gas to its molar mass

(C) Volume to pressure at constant temperature

(D) Vapour pressure of a liquid to temperature

60. In an ideal binary solution the mole fraction of A is 0.4. If the vapour pressures of pure A and pure B are 100 kPa and 50 kPa, the total vapour pressure is:

(A) 75 kPa (B) 70 kPa

(C) 150 kPa (D) 60 kPa

Part II

Physics

61. A ball is projected at 45° to the horizontal with a speed of 20 m/s. Its horizontal range is ($g = 10\ m/s^2$):

(A) 10 m (B) 20 m

(C) 80 m (D) 40 m

62. In an Atwood machine, masses of 3 kg and 2 kg hang from a light string over a frictionless pulley. The acceleration of the masses is ($g = 10\ m/s^2$):

(A) $10\ m/s^2$ (B) $5\ m/s^2$

(C) $3.3\ m/s^2$ (D) $2\ m/s^2$

63. The moment of inertia of a uniform solid sphere of mass M and radius R about a diameter is:

(A) $(2/3)\ MR^2$ (B) $(2/5)\ MR^2$

(C) $(7/5)\ MR^2$ (D) $(1/2)\ MR^2$

64. Two tuning forks of frequencies 256 Hz and 260 Hz are sounded together. The number of beats heard per second is:

(A) 516 (B) 2

(C) 4 (D) 8

65. An object is placed 30 cm in front of a convex lens of focal length 20 cm. The image is formed:

(A) 60 cm behind the lens (B) 12 cm behind the lens

(C) 20 cm behind the lens (D) 60 cm in front of the lens

66. In Young's double-slit experiment, light of wavelength 600 nm is used, the slit separation is 1 mm and the screen is 1 m away. The fringe width is:

(A) 1.2 mm (B) 0.6 mm

(C) 0.06 mm (D) 6 mm

67. A 10 μF capacitor is charged to 100 V. The energy stored in it is:

(A) 0.05 J (B) 0.001 J

(C) 5 J (D) 0.5 J

68. By the law of equipartition of energy, the molar heat capacity at constant volume of a diatomic gas at room temperature is:

(A) 3R/2 (B) 5R/2
(C) 7R/2 (D) 3R

69. In the Bohr model of the hydrogen atom, the energy of the electron in the second orbit (n = 2) is:

(A) –6.8 eV (B) –13.6 eV
(C) –3.4 eV (D) –1.51 eV

70. The half-life of a radioactive sample is 10 days. The fraction of the sample left undecayed after 30 days is:

(A) 1/27 (B) 1/6
(C) 1/8 (D) 1/3

Part III

Chemistry

71. The maximum number of electrons that can be accommodated in the shell with n = 3 is:

(A) 32 (B) 8
(C) 18 (D) 9

72. The ground-state electronic configuration of chromium (Z = 24) is:

(A) [Ar] $3d^5\ 4s^1$ (B) [Ar] $3d^6$
(C) [Ar] $4s^2\ 4p^4$ (D) [Ar] $3d^4\ 4s^2$

73. Which of the following elements has the highest first ionisation enthalpy?

(A) B (B) O
(C) N (D) C

74. The higher calorific value of a fuel containing 10% hydrogen is 8000 kcal/kg. Taking the latent heat of steam as 587 kcal/kg, its lower calorific value is about:

(A) 7941 kcal/kg (B) 7413 kcal/kg
(C) 8528 kcal/kg (D) 7472 kcal/kg

75. On the octane rating scale, the two reference fuels assigned ratings of 100 and 0 respectively are:

(A) n-Heptane and iso-octane
(B) Benzene and n-hexane
(C) Iso-octane and n-heptane
(D) n-Hexadecane and α-methylnaphthalene

76. A water sample contains 16.2 mg/L of $Ca(HCO_3)_2$ (molar mass 162). Its hardness in terms of $CaCO_3$ equivalent is:

(A) 10 ppm (B) 16.2 ppm
(C) 1.62 ppm (D) 20 ppm

77. Temporary hardness of water is caused by:

(A) Chlorides of Ca and Mg
(B) Nitrates of sodium and potassium
(C) Sulphates of Ca and Mg
(D) Bicarbonates of Ca and Mg

78. In the ion-exchange process of softening water, a cation-exchange resin in its H^+ form replaces the Ca^{2+} and Mg^{2+} ions by:

(A) H^+ ions
(B) Na^+ ions
(C) Cl^- ions
(D) OH^- ions

79. Minamata disease, a well-known case of heavy-metal poisoning, was caused by:

(A) Arsenic
(B) Lead
(C) Mercury
(D) Cadmium

80. Galvanised iron is iron coated with:

(A) Tin
(B) Zinc
(C) Chromium
(D) Nickel

Part IV

Mathematics

81. If α and β are the roots of $x^2 - 5x + 6 = 0$, then $\alpha^2 + \beta^2$ equals:

(A) 25
(B) 12
(C) 37
(D) 13

82. The rank of the matrix below is:

```
1   2   3
2   4   6
1   1   1
```

(A) 2
(B) 0
(C) 3
(D) 1

83. The value of $\sin 75^\circ$ is:

(A) $(\sqrt{6} - \sqrt{2})/4$
(B) $(\sqrt{3} - 1)/2$
(C) $(\sqrt{6} + \sqrt{2})/4$
(D) $(\sqrt{3} + 1)/2$

84. The perpendicular distance of the point (3, 4) from the line $3x + 4y - 5 = 0$ is:

(A) 4
(B) 5
(C) 3
(D) 20

85. The centre and radius of the circle $x^2 + y^2 - 4x + 6y - 12 = 0$ are:

(A) (2, –3) and 5
(B) (2, –3) and 25
(C) (–2, 3) and $\sqrt{12}$
(D) (–2, 3) and 5

86. The radius of curvature of the curve $y = x^2$ at the origin is:

(A) 1/2
(B) 1/4
(C) 1
(D) 2

87. If $x = r\cos\theta$ and $y = r\sin\theta$, the Jacobian $\partial(x, y)/\partial(r, \theta)$ is:

(A) r
(B) r^2
(C) 1
(D) $1/r$

88. The value of $\int_0^{(\pi/2)} \sin^4 x\, dx$ is:

(A) $\pi/16$
(B) $3\pi/16$
(C) $3\pi/8$
(D) $\pi/4$

89. The divergence of the position vector r = x i + y j + z k is:

(A) r (B) 1

(C) 0 (D) 3

90. The integrating factor of the equation dy/dx + 2y = e^x is:

(A) 2x (B) e^(2x)

(C) e^x (D) e^(–2x)

Part V

General Aptitude and Communication Skills

91. If COLD is written as DPME in a certain code, how is WARM written in that code?

(A) VZQL (B) XASN

(C) XBSN (D) XBSM

92. In a certain code, TABLE is written as GZYOV. How is CHAIR written in that code?

(A) XSZIR (B) XTZRI

(C) WSZRI (D) XSZRI

93. Ravi walks 5 km north, turns right and walks 3 km, then turns right again and walks 9 km. How far is he now from his starting point?

(A) 17 km (B) 4 km

(C) 7 km (D) 5 km

94. A man is facing north. He turns 90° clockwise and then 180° anticlockwise. Which direction is he facing now?

(A) South (B) East

(C) West (D) North

95. Find the next number in the series: 2, 6, 12, 20, 30, ?

(A) 36 (B) 40

(C) 42 (D) 44

96. Choose the pair that shows the same relationship as DOCTOR : HOSPITAL

(A) Lawyer : Judgement (B) Author : Book

(C) Teacher : School (D) Farmer : Harvest

97. Fill in the blank: By next June, she ___ her diploma.

(A) would have been completed (B) will have completed

(C) has completed (D) had completed

98. Fill in the blank with the correct article: ___ Ganga rises in the Himalayas.

(A) No article (B) A

(C) The (D) An

99. Choose the passive form of: 'Who wrote this report?'

(A) Who was this report written?

(B) By whom was this report written?

(C) Who has written this report?

(D) By whom this report was written?

100. Choose the sentence in which the words are in the correct order:

(A) She always reaches the office on time.

(B) She reaches the office always time on.

(C) Always she reaches on time the office.

(D) She reaches always the office on time.

Answer Key

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

Solutions

Basic Electrical Engineering

1. (B) For a balanced network, R_star = R_delta/3 = 9/3 = 3 Ω.

2. (C) I_N = short-circuit current = 10/5 = 2 A, with R_N = 5 Ω in parallel with the current source.

3. (C) $\tau = RC = 10 \times 10^3 \times 100 \times 10^{-6} = 1$ s. (About 5τ = 5 s is the time to charge almost fully.)

4. (D) $V_{rms} = V_m/\sqrt{2} = 325/1.414 \approx 230$ V. (207 V is the average value over a half cycle, 0.637 V_m.)

5. (D) In delta connection $I_{line} = \sqrt{3} \times I_{phase} = 1.732 \times 10 \approx 17.3$ A.

6. (C) Reluctance (S = l/μA) opposes flux as resistance opposes current. MMF is analogous to EMF, flux to current and permeance to conductance.

7. (A) $V_2 = V_1 \times N_2/N_1 = 230 \times 200/2000 = 23$ V (a step-down transformer).

8. (C) Maximum efficiency occurs where copper loss = iron loss: $x^2 \times 400 = 100$, so x = 0.5, i.e. half load.

9. (B) $E_b = V - I_a R_a = 220 - 10 \times 0.5 = 215$ V.

10. (A) Steps per revolution = 360°/1.8° = 200.

Basic Electronics

11. (B) A reverse-biased varactor's junction capacitance changes with the applied voltage, so it works as a voltage-controlled (variable) capacitor, e.g. in tuning circuits. The Zener is the voltage regulator.

12. (A) $\eta_{max} = 4/\pi^2 \approx 0.406 = 40.6\%$ for a half-wave rectifier. A full-wave rectifier reaches 81.2%.

13. (D) $I_C = \beta I_B = 100 \times 20$ μA = 2000 μA = 2 mA.

14. (A) Inverting gain = $-R_f/R_1 = -100/10 = -10$. (+11 would be the non-inverting gain $1 + R_f/R_1$.)

15. (C) For sustained oscillation the loop gain magnitude $|A\beta| = 1$ and the total phase shift round the loop is 0° (or 360°).

16. (B) NAND and NOR are universal gates: any logic function can be built using only one of them.

17. (A) $A + AB = A(1 + B) = A \cdot 1 = A$ (absorption law).

18. (A) n select lines choose among 2^n inputs; $2^3 = 8$, so 3 select lines are needed.

19. (D) A thermocouple produces an EMF (Seebeck effect) without an external supply. Strain gauges, thermistors and LVDTs need an excitation source, so they are passive.

20. (C) $P_t = P_c (1 + m^2/2) = P_c (1 + 1/2) = 1.5 P_c$.

Programming Fundamentals

21. (D) In the memory hierarchy, registers inside the CPU are fastest, followed by cache, main memory and secondary storage.

22. (A) pwd (print working directory) shows the full path. ls and dir list files and cd changes the directory.

23. (A) Both operands are int, so integer division truncates 3.5 to 3.

24. (B) Post-increment uses the old value 5 in the expression (b = 10) and then increases a to 6.

25. (B) 12 = 1100 in binary; shifting right by 2 gives 0011 = 3 (the same as 12/4). 12 << 2 would give 48.

26. (D) i takes the values 0, 3, 6 and 9; at i = 12 the condition fails. So the body runs 4 times.

27. (B) p points to a[0]; p + 2 points to a[2], whose value is 30.

28. (C) f(4) = 4 + 3 + 2 + 1 + 0 = 10. (24 would be 4!, the product.)

29. (D) All members of a union share the same memory, so its size is that of the largest member (plus any alignment padding). A structure takes the sum of its members.

30. (D) Encapsulation wraps data and methods together in a class. Abstraction hides details, inheritance reuses a class and polymorphism gives one interface many forms.

Fundamentals of Mechanical Engineering

31. (D) Kelvin–Planck: it is impossible for a cyclic engine to exchange heat with a single reservoir and convert all of it into work, i.e. no engine is 100% efficient. The heat-transfer statement is Clausius's.

32. (D) COP_ref = T_L/(T_H − T_L) = 250/50 = 5. (6 is the COP of a heat pump between the same temperatures.)

33. (B) x = mass of dry vapour ÷ total mass = 0.8/(0.8 + 0.2) = 0.8.

34. (A) $\eta = 1 - 1/r^{(\gamma-1)} = 1 - 1/8^{0.4} = 1 - 1/2.297 \approx 0.565 = 56.5\%$.

35. (B) The Diesel cycle adds heat at constant pressure. The Otto cycle adds it at constant volume.

36. (B) Continuity: $A_1V_1 = A_2V_2$. Halving the diameter makes the area one-fourth, so $V_2 = 4 \times 2 = 8$ m/s.

37. (B) $\delta = PL/(AE) = (10\,000\ \text{N} \times 1000\ \text{mm})/(100\ \text{mm}^2 \times 200\,000\ \text{N/mm}^2) = 0.5$ mm.

38. (C) The bending moment at distance x from the free end is Wx, which is largest (WL) at the fixed end and zero at the free end.

39. (B) Each reaction is wL/2; at mid-span $M = (wL/2)(L/2) - (wL/2)(L/4) = wL^2/8$. ($wL^2/2$ is the cantilever value.)

40. (A) $J = \pi d^4/32$, which is twice the second moment of area about a diameter ($\pi d^4/64$).

Fundamentals of Civil Engineering

41. (A) The DPC is laid at plinth level to stop ground moisture rising into the walls.

42. (B) $p = \rho gh = 1000 \times 9.81 \times 10 = 98\,100$ Pa ≈ 98.1 kPa (gauge).

43. (C) The slump test measures the consistency (workability) of fresh concrete. Strength is found by cube tests.

44. (D) In an under-reinforced section the steel reaches yield before the concrete crushes, giving a ductile failure with warning. Over-reinforced beams fail by concrete crushing.

45. (B) ISMB 300 is an Indian Standard Medium weight Beam with an overall depth of 300 mm.

46. (A) Height of instrument = 100.000 + 1.500 = 101.500 m. RL of P = 101.500 − 2.000 = 99.500 m.

47. (C) 240° lies in the third (SW) quadrant. RB = WCB − 180° = 60°, written S 60° W.

48. (D) $\Delta = 8.64\ B/D = 8.64 \times 120/1728 = 0.6$ m (Δ in m, B in days, D in ha/cumec).

49. (B) Camber is the cross slope that drains rainwater to the sides. Super-elevation on curves counteracts centrifugal force.

50. (A) $n = e/(1 + e) = 0.5/1.5 \approx 0.33$.

Fundamentals of Chemical Engineering

51. (D) 300 K = 26.85 °C. °F = 1.8 × 26.85 + 32 ≈ 80.3 °F. (48.3 forgets to add 32.)

52. (B) Dynamic viscosity is shear stress ÷ velocity gradient, so its unit is Pa·s (kg m^{-1} s^{-1}). m^2/s is the unit of kinematic viscosity.

53. (D) Moles: O_2 = 64/32 = 2, N_2 = 28/28 = 1. Mole fraction of O_2 = 2/3 ≈ 0.667. (0.696 is the mass fraction.)

54. (A) Distillation separates components physically, so it is a unit operation. Nitration, sulphonation and hydrogenation are chemical reactions (unit processes).

55. (D) Salt in = 100 kg/h = 0.4 × product, so product = 250 kg/h. Water evaporated = 1000 − 250 = 750 kg/h.

56. (C) $C + O_2 \rightarrow CO_2$: 12 kg C needs 32 kg O_2, so 24 kg C needs 64 kg O_2. (88 kg is the CO_2 formed.)

57. (D) n = PV/RT = (2 × 24.6)/(0.082 × 300) = 49.2/24.6 = 2.

58. (C) 'a' accounts for intermolecular attraction, which lowers the observed pressure. 'b' accounts for the finite volume of the molecules.

59. (D) $\ln(p_2/p_1) = (\Delta H_vap/R)(1/T_1 - 1/T_2)$ links vapour pressure with temperature. Boyle's law and Henry's law cover the next two.

60. (B) Raoult's law: P = 0.4 × 100 + 0.6 × 50 = 40 + 30 = 70 kPa.

Physics

61. (D) $R = u^2 \sin 2\theta/g$ = 400 × 1/10 = 40 m.

62. (D) $a = (m_1 - m_2)g/(m_1 + m_2)$ = (1 × 10)/5 = 2 m/s^2.

63. (B) For a solid sphere $I = (2/5)MR^2$. $(2/3)MR^2$ is a thin spherical shell and $(7/5)MR^2$ is about a tangent.

64. (C) Beat frequency = difference of frequencies = 260 − 256 = 4 per second.

65. (A) 1/v − 1/u = 1/f with u = −30 cm, f = +20 cm: 1/v = 1/20 − 1/30 = 1/60, so v = +60 cm (real image on the other side).

66. (B) $\beta = \lambda D/d = (600 \times 10^{-9} \times 1)/(1 \times 10^{-3}) = 6 \times 10^{-4}$ m = 0.6 mm.

67. (A) $U = \frac{1}{2}CV^2 = \frac{1}{2} \times 10 \times 10^{-6} \times 10^4$ = 0.05 J.

68. (B) A diatomic molecule has 3 translational + 2 rotational degrees of freedom; each contributes R/2, so C_v = 5R/2.

69. (C) $E_n = -13.6/n^2$ eV, so $E_2 = -13.6/4 = -3.4$ eV. (−1.51 eV is n = 3.)

70. (C) 30 days = 3 half-lives, so the fraction left is $(1/2)^3$ = 1/8.

Chemistry

71. (C) A shell holds $2n^2$ electrons: 2×3^2 = 18.

72. (A) Chromium has the exceptional configuration $3d^5\ 4s^1$ because a half-filled d subshell is extra stable.

73. (C) Ionisation enthalpy generally rises across period 2, but N (half-filled $2p^3$) is higher than O ($2p^4$), from which one paired electron is removed easily. Order: N > O > C > B.

74. (D) LCV = HCV − 0.09 H × 587 = 8000 − 0.09 × 10 × 587 = 8000 − 528.3 ≈ 7472 kcal/kg. (Each kg of H gives 9 kg of water.)

75. (C) Iso-octane (2,2,4-trimethylpentane) is rated 100 and n-heptane 0. n-Hexadecane and α-methylnaphthalene are the references for the cetane scale.

76. (A) Hardness as $CaCO_3$ = 16.2 × 100/162 = 10 mg/L = 10 ppm (1 mol of $Ca(HCO_3)_2$ ≡ 1 mol of $CaCO_3$, molar mass 100).

77. (D) Temporary hardness comes from the bicarbonates of calcium and magnesium and is removed by boiling. Chlorides and sulphates cause permanent hardness.

78. (A) The cation exchanger RH_2 takes up Ca^{2+}/Mg^{2+} and releases H^+. The anion exchanger then replaces anions by OH^-.

79. (C) Minamata disease in Japan was caused by methylmercury in fish from contaminated sea water. Cadmium caused itai-itai disease.

80. (B) Galvanising coats iron with zinc, which protects it sacrificially even if scratched. Tin plating is used for food cans.

Mathematics

81. (D) $\alpha + \beta = 5$ and $\alpha\beta = 6$, so $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta = 25 - 12 = 13$.

82. (A) Row 2 = 2 × row 1, so the determinant is 0 and the rank is less than 3. Rows 1 and 3 are not proportional, so the rank is 2.

83. (C) $\sin 75^\circ = \sin(45^\circ + 30^\circ) = (1/\sqrt{2})(\sqrt{3}/2) + (1/\sqrt{2})(1/2) = (\sqrt{3} + 1)/(2\sqrt{2}) = (\sqrt{6} + \sqrt{2})/4$.

84. (A) $d = |3 \times 3 + 4 \times 4 - 5|/\sqrt{(3^2 + 4^2)} = 20/5 = 4$.

85. (A) Centre $(-g, -f) = (2, -3)$; radius $= \sqrt{(g^2 + f^2 - c)} = \sqrt{(4 + 9 + 12)} = 5$.

86. (A) $\rho = (1 + y'^2)^{(3/2)}/|y''|$. At the origin $y' = 0$ and $y'' = 2$, so $\rho = 1/2$.

87. (A) $J = x_r\, y_\theta - x_\theta\, y_r = \cos\theta \cdot r\cos\theta - (-r\sin\theta) \cdot \sin\theta = r$.

88. (B) By the reduction (Wallis) formula: $(3/4)(1/2)(\pi/2) = 3\pi/16$.

89. (D) $\operatorname{div} \mathbf{r} = \partial x/\partial x + \partial y/\partial y + \partial z/\partial z = 1 + 1 + 1 = 3$.

90. (B) $IF = e^{(\int 2\, dx)} = e^{(2x)}$.

General Aptitude and Communication Skills

91. (C) Each letter is moved one place forward: W→X, A→B, R→S, M→N, giving XBSN.

92. (D) Each letter is replaced by its mirror letter (A↔Z, B↔Y, ...): position p becomes 27 − p. C→X, H→S, A→Z, I→R, R→I gives XSZRI.

93. (D) He ends 3 km east and 9 − 5 = 4 km south of the start. Distance $= \sqrt{(3^2 + 4^2)} = 5$ km.

94. (C) North → 90° clockwise → East → 180° anticlockwise → West.

95. (C) The terms are 1×2, 2×3, 3×4, 4×5, 5×6, so the next is 6×7 = 42 (differences 4, 6, 8, 10, 12).

96. (C) A doctor works in a hospital; a teacher works in a school. The other pairs link a person to something produced, not to a workplace.

97. (B) 'By next June' marks an action finished before a future point, which needs the future perfect: 'will have completed'.

98. (C) Names of rivers take the definite article: 'The Ganga'.

99. (B) 'Who' becomes 'By whom', and the question keeps the auxiliary before the subject: 'By whom was this report written?'

100. (A) Frequency adverbs such as 'always' come before the main verb, and the object comes before the adverbial 'on time'.