

GATE Electrical Engineering

5 Practice Sets with Answers and Worked Solutions

Contents	5 sets × 20 questions = 100 questions. Each set is worth 30 marks and covers every section of the GATE 2027 EE syllabus.
Question types	MCQ: one correct option. MSQ: one or more correct options. NAT: numerical answer to be entered.
Marking	MCQ wrong answer: -1/3 (1-mark) or -2/3 (2-mark). No negative marks for MSQ or NAT.
How to use	Attempt each set in about 45 minutes, then check the answer key and solutions that follow it.

Set layout

Section	Questions per set
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Set 1: Questions

20 questions · 30 marks · 45 minutes

General Aptitude

Q1. [MCQ, 1 mark] Choose the word that is most nearly OPPOSITE in meaning to EPHEMERAL.

- (A) Transient
- (B) Permanent
- (C) Fleeting
- (D) Brief

Q2. [NAT, 2 marks] Pipe A can fill a tank in 12 hours and pipe B in 15 hours. Pipe C can empty the full tank in 20 hours. If all three pipes are opened together on an empty tank, the time taken to fill it is _____ hours.

Engineering Mathematics

Q3. [MCQ, 1 mark] The eigenvalues of the matrix $A = \begin{bmatrix} 4 & 1 \\ 2 & 3 \end{bmatrix}$ are

- (A) 2 and 5
- (B) 1 and 6
- (C) -2 and -5
- (D) 3 and 4

Q4. [NAT, 2 marks] The value of $(1/2\pi j) \oint_C z / [(z - 1)(z - 3)] dz$, where the contour is the circle $|z| = 2$ traversed anticlockwise, is _____.

Electric Circuits

Q5. [NAT, 2 marks] A 12 V ideal DC source in series with a 4Ω resistor feeds terminals a-b, across which a 12Ω resistor is connected. A variable load resistor R_L is connected across a-b. The maximum power that can be delivered to R_L is _____ W.

Q6. [MCQ, 1 mark] A series RLC circuit has $R = 10 \Omega$, $L = 10 \text{ mH}$ and $C = 100 \mu\text{F}$. Its resonant frequency and quality factor are

- (A) 159.2 Hz, $Q = 1$
- (B) 1000 Hz, $Q = 1$
- (C) 159.2 Hz, $Q = 10$
- (D) 1000 Hz, $Q = 0.1$

Electromagnetic Fields

Q7. [NAT, 1 mark] A parallel-plate capacitor has plate area 0.01 m^2 , plate separation 1 mm and a dielectric of relative permittivity 5. Taking $\epsilon_0 = 8.854 \times 10^{-12} \text{ F/m}$, its capacitance is _____ pF.

Q8. [MSQ, 1 mark] Which of the following are valid Maxwell's equations (in point form) for time-varying fields?

- (A) $\nabla \cdot \mathbf{B} = 0$
- (B) $\nabla \times \mathbf{E} = -\partial \mathbf{B} / \partial t$
- (C) $\nabla \cdot \mathbf{D} = 0$ in all regions
- (D) $\nabla \times \mathbf{H} = \mathbf{J} + \partial \mathbf{D} / \partial t$

Signals and Systems

Q9. [MCQ, 2 marks] The Nyquist sampling rate for the signal $x(t) = \cos(200\pi t) \cdot \cos(300\pi t)$ is

- (A) 300 Hz
- (B) 500 Hz
- (C) 250 Hz
- (D) 1000 Hz

Q10. [NAT, 1 mark] The Laplace transform of a signal $x(t)$ is $X(s) = (5s + 10) / [s(s + 1)(s + 2)]$. The final value of $x(t)$ as $t \rightarrow \infty$ is _____.

Electrical Machines

Q11. [NAT, 1 mark] A 4-pole, 50 Hz, three-phase induction motor runs at 1440 rpm. If the air-gap power is 10 kW, the rotor copper loss is _____ W.

Q12. [NAT, 2 marks] A 10 kVA single-phase transformer has an iron loss of 200 W and full-load copper loss of 400 W. The load at which maximum efficiency occurs is _____ kVA (rounded to two decimal places).

Power Systems

Q13. [NAT, 1 mark] A generator rated 50 MVA, 11 kV has a reactance of 0.2 pu on its own rating. On a base of 100 MVA, 12 kV its reactance is _____ pu (rounded to three decimal places).

Q14. [MCQ, 2 marks] An unloaded generator with $E = 1.0$ pu has $Z_1 = Z_2 = j0.2$ pu and $Z_0 = j0.1$ pu (neutral solidly grounded). The magnitude of fault current for a bolted single line-to-ground fault at its terminals is

- (A) 5.0 pu
- (B) 6.0 pu
- (C) 2.0 pu
- (D) 3.33 pu

Control Systems

Q15. [NAT, 2 marks] A unity-feedback system has open-loop transfer function $G(s) = K / [s(s + 4)]$. The value of K for which the closed-loop damping ratio is 0.5 is _____.

Q16. [MCQ, 1 mark] The system with characteristic equation $s^3 + 2s^2 + Ks + 8 = 0$ is stable for

- (A) $K > 4$
- (B) $K > 2$
- (C) $0 < K < 4$
- (D) $K > 8$

Electrical & Electronic Measurements

Q17. [NAT, 2 marks] In the two-wattmeter method of measuring power in a balanced three-phase load, the readings are $W_1 = 10 \text{ kW}$ and $W_2 = 5 \text{ kW}$. The power factor of the load is _____ (rounded to three decimal places).

Analog and Digital Electronics

Q18. [NAT, 1 mark] An ideal op-amp is used as a non-inverting amplifier with $R_f = 90 \text{ k}\Omega$ and $R_1 = 10 \text{ k}\Omega$. It is powered from $\pm 12 \text{ V}$ supplies and its output saturates at the supply rails. For a DC input of 1.5 V , the output voltage is _____ V.

Q19. [MSQ, 2 marks] A Boolean function is given by $F(A, B, C) = \sum m(1, 3, 5, 7)$. Which of the following statements is/are correct?

- (A) $F = C$
- (B) F is independent of A and B
- (C) $F = A + C$
- (D) $F' = \sum m(0, 2, 4, 6)$

Power Electronics

Q20. [NAT, 2 marks] A single-phase fully-controlled thyristor bridge rectifier is fed from 230 V (rms), 50 Hz . The load current is continuous and ripple-free. For a firing angle of 60° , the average output voltage is _____ V.

Set 1: Answer Key and Solutions

Q	Type	Marks	Answer
1	MCQ	1	(B) Permanent
2	NAT	2	10
3	MCQ	1	(A) 2 and 5
4	NAT	2	-0.5
5	NAT	2	6.75
6	MCQ	1	(A) 159.2 Hz, $Q = 1$
7	NAT	1	442.7 (accept 442 to 443)
8	MSQ	1	(A), (B), (D)
9	MCQ	2	(B) 500 Hz
10	NAT	1	5
11	NAT	1	400
12	NAT	2	7.07 (accept 7.05 to 7.10)
13	NAT	1	0.336 (accept 0.33 to 0.34)
14	MCQ	2	(B) 6.0 pu
15	NAT	2	16
16	MCQ	1	(A) $K > 4$
17	NAT	2	0.866 (accept 0.86 to 0.87)
18	NAT	1	12
19	MSQ	2	(A), (B), (D)
20	NAT	2	103.5 (accept 103 to 104)

Worked solutions

Q1. Answer: (B) Permanent

Ephemeral means lasting a very short time; its opposite is permanent.

Q2. Answer: 10

Net rate = $1/12 + 1/15 - 1/20 = (5 + 4 - 3)/60 = 1/10$ tank per hour, so 10 hours.

Q3. Answer: (A) 2 and 5

Trace = 7, determinant = $12 - 2 = 10$. Roots of $\lambda^2 - 7\lambda + 10 = 0$ are 2 and 5.

Q4. Answer: -0.5

Only $z = 1$ lies inside $|z| = 2$. Residue at $z = 1$ is $1/(1 - 3) = -0.5$.

Q5. Answer: 6.75

$V_{th} = 12 \times 12/16 = 9$ V; $R_{th} = 4 \parallel 12 = 3$ Ω . $P_{max} = V_{th}^2/(4R_{th}) = 81/12 = 6.75$ W.

Q6. Answer: (A) 159.2 Hz, $Q = 1$

$\omega_0 = 1/\sqrt{LC} = 1/\sqrt{10^{-6}} = 1000$ rad/s, so $f_0 = 159.2$ Hz. $Q = (1/R)\sqrt{L/C} = 0.1 \times \sqrt{100} = 1$.

Q7. Answer: 442.7 (accept 442 to 443)

$$C = \epsilon_0 \epsilon_r A/d = 8.854 \times 10^{-12} \times 5 \times 0.01 / 0.001 = 442.7 \text{ pF.}$$

Q8. Answer: (A), (B), (D)

$\nabla \cdot D = \rho_v$, which is zero only in charge-free regions, so (C) is not valid in general.

Q9. Answer: (B) 500 Hz

The product equals $\frac{1}{2}[\cos(100\pi t) + \cos(500\pi t)]$, with components at 50 Hz and 250 Hz.

Highest frequency 250 Hz, so Nyquist rate = 500 Hz.

Q10. Answer: 5

Poles of $sX(s)$ are at -1 and -2 (left half-plane), so the final value theorem applies: $\lim_{s \rightarrow 0} sX(s) = 10/2 = 5$.

Q11. Answer: 400

$$N_s = 120 \times 50/4 = 1500 \text{ rpm}; s = (1500 - 1440)/1500 = 0.04. \text{ Rotor copper loss} = s \times P_{ag} = 0.04 \times 10000 = 400 \text{ W.}$$

Q12. Answer: 7.07 (accept 7.05 to 7.10)

Maximum efficiency when copper loss = iron loss: $x = \sqrt{(200/400)} = 0.707$, so load = $0.707 \times 10 = 7.07 \text{ kVA}$.

Q13. Answer: 0.336 (accept 0.33 to 0.34)

$$X_{\text{new}} = 0.2 \times (100/50) \times (11/12)^2 = 0.336 \text{ pu.}$$

Q14. Answer: (B) 6.0 pu

$$I_f = 3E/(Z_1 + Z_2 + Z_0) = 3/0.5 = 6 \text{ pu. (5.0 pu would be the three-phase fault current.)}$$

Q15. Answer: 16

Characteristic equation: $s^2 + 4s + K = 0$. $2\zeta\omega_n = 4$ with $\zeta = 0.5$ gives $\omega_n = 4$, so $K = \omega_n^2 = 16$.

Q16. Answer: (A) $K > 4$

Routh array: s^3 : 1, K; s^2 : 2, 8; s^1 : $(2K - 8)/2$; s^0 : 8. Stability needs $2K - 8 > 0$, so $K > 4$.

Q17. Answer: 0.866 (accept 0.86 to 0.87)

$$\tan \phi = \sqrt{3}(W_1 - W_2)/(W_1 + W_2) = \sqrt{3} \times 5/15 = 0.577, \text{ so } \phi = 30^\circ \text{ and pf} = \cos 30^\circ = 0.866 \text{ (lagging).}$$

Q18. Answer: 12

Gain = $1 + 90/10 = 10$, so the ideal output would be 15 V. This exceeds +12 V, so the output saturates at 12 V.

Q19. Answer: (A), (B), (D)

Minterms 1, 3, 5, 7 are exactly those with $C = 1$, so $F = C$, independent of A and B. The complement contains the remaining minterms 0, 2, 4, 6.

Q20. Answer: 103.5 (accept 103 to 104)

$$V_o = (2V_m/\pi) \cos \alpha = (2 \times 230\sqrt{2}/\pi) \times 0.5 = 207.07 \times 0.5 = 103.5 \text{ V.}$$

Set 2: Questions

20 questions · 30 marks · 45 minutes

General Aptitude

Q1. [MCQ, 1 mark] Choose the correct preposition: "She is senior _____ me by two years."

- (A) than
- (B) to
- (C) from
- (D) over

Q2. [NAT, 2 marks] A shopkeeper marks an article 40% above its cost price and then allows a discount of 10% on the marked price. His profit percentage is _____.

Engineering Mathematics

Q3. [MCQ, 1 mark] The rank of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 1 & 1 & 1 \end{bmatrix}$ is

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

Q4. [NAT, 2 marks] If $dy/dx + 2y = 0$ with $y(0) = 3$, the value of $y(1)$ is _____ (rounded to two decimal places).

Electric Circuits

Q5. [NAT, 2 marks] A 20 V DC source is switched at $t = 0$ onto a series circuit of $R = 10 \Omega$ and $L = 0.5 \text{ H}$ with zero initial current. The current at $t = 50 \text{ ms}$ is _____ A (rounded to two decimal places).

Q6. [MCQ, 1 mark] Three equal resistors of 30Ω connected in delta are converted to an equivalent star. Each star resistance is

- (A) 10Ω
- (B) 90Ω
- (C) 30Ω
- (D) 15Ω

Electromagnetic Fields

Q7. [NAT, 1 mark] The magnitude of the electric field at a distance of 1 m from a point charge of 1 nC in free space is _____ V/m (take $1/(4\pi\epsilon_0) = 8.99 \times 10^9$).

Q8. [MCQ, 1 mark] Two long parallel conductors carry currents in the same direction. The force between them is

- (A) attractive
- (B) repulsive
- (C) zero
- (D) dependent only on distance, not on current

Signals and Systems

Q9. [MCQ, 2 marks] The system $y(t) = x(2t)$ is

- (A) linear and time-invariant
- (B) linear and time-variant
- (C) nonlinear and time-invariant
- (D) nonlinear and time-variant

Q10. [NAT, 1 mark] The fundamental period of $x[n] = \cos(\pi n/4) + \sin(\pi n/6)$ is _____ samples.

Electrical Machines

Q11. [NAT, 1 mark] A 6-pole alternator runs at 1000 rpm. The frequency of the generated EMF is _____ Hz.

Q12. [NAT, 2 marks] A 220 V DC shunt motor has armature resistance 0.5Ω and runs at 1000 rpm drawing an armature current of 40 A. If the load increases so that the armature current becomes 60 A, with flux constant, the new speed is _____ rpm.

Power Systems

Q13. [NAT, 1 mark] A 400 kV transmission line has a surge impedance of 400Ω . Its surge impedance loading is _____ MW.

Q14. [MCQ, 2 marks] A generator with internal EMF 1.2 pu is connected to an infinite bus of 1.0 pu through a total reactance of 0.6 pu. When delivering 1.0 pu power, the load angle is

- (A) 30°
- (B) 45°
- (C) 60°
- (D) 19.5°

Control Systems

Q15. [NAT, 2 marks] A unity-feedback system has $G(s) = 20 / [s(s + 5)]$. The steady-state error for a unit ramp input is _____.

Q16. [MCQ, 1 mark] For an open-loop transfer function with 3 poles and no finite zeros, the angles of the root-locus asymptotes are

- (A) $60^\circ, 180^\circ, 300^\circ$
- (B) $0^\circ, 120^\circ, 240^\circ$
- (C) $45^\circ, 135^\circ, 225^\circ$
- (D) $90^\circ, 270^\circ$

Electrical & Electronic Measurements

Q17. [NAT, 2 marks] A PMMC instrument has full-scale current 1 mA and internal resistance 100Ω . The shunt resistance needed to extend its range to 1 A is _____ Ω (rounded to three decimal places).

Analog and Digital Electronics

Q18. [MCQ, 1 mark] The minimum number of flip-flops required to build a mod-12 counter is

- (A) 3
- (B) 4
- (C) 6
- (D) 12

Q19. [NAT, 2 marks] A fixed-bias BJT circuit has $V_{CC} = 12\text{ V}$, $R_B = 565\text{ k}\Omega$, $R_C = 2\text{ k}\Omega$, $\beta = 100$ and $V_{BE} = 0.7\text{ V}$. The collector-emitter voltage V_{CE} is _____ V.

Power Electronics

Q20. [MSQ, 2 marks] Which of the following devices can be both turned ON and turned OFF through their gate terminal?

- (A) SCR
- (B) IGBT
- (C) Power MOSFET
- (D) Power diode

Set 2: Answer Key and Solutions

Q	Type	Marks	Answer
1	MCQ	1	(B) to
2	NAT	2	26
3	MCQ	1	(B) 2
4	NAT	2	0.41 (accept 0.40 to 0.41)
5	NAT	2	1.26 (accept 1.25 to 1.27)
6	MCQ	1	(A) $10\ \Omega$
7	NAT	1	8.99 (accept 8.9 to 9.0)
8	MCQ	1	(A) attractive
9	MCQ	2	(B) linear and time-variant
10	NAT	1	24
11	NAT	1	50
12	NAT	2	950
13	NAT	1	400
14	MCQ	2	(A) 30°
15	NAT	2	0.25
16	MCQ	1	(A) 60° , 180° , 300°
17	NAT	2	0.100 (accept 0.099 to 0.101)
18	MCQ	1	(B) 4
19	NAT	2	8
20	MSQ	2	(B), (C)

Worked solutions

Q1. Answer: (B) to

Words such as senior, junior, superior and inferior take "to", not "than".

Q2. Answer: 26

Selling price = $1.40 \times 0.90 = 1.26 \times$ cost price, so profit = 26%.

Q3. Answer: (B) 2

Row 2 = $2 \times$ Row 1, so they are dependent. Row 3 is not a multiple of Row 1, so the rank is 2.

Q4. Answer: 0.41 (accept 0.40 to 0.41)

$y = 3e^{-2x}$, so $y(1) = 3e^{-2} = 0.406$.

Q5. Answer: 1.26 (accept 1.25 to 1.27)

$\tau = L/R = 0.05\text{ s}$; final current = 2 A. $i(t) = 2(1 - e^{-t/\tau})$, so $i(0.05) = 2(1 - e^{-1}) = 1.264\text{ A}$.

Q6. Answer: (A) $10\ \Omega$

For a balanced network, $R_Y = R_\Delta/3 = 10\ \Omega$.

Q7. Answer: 8.99 (accept 8.9 to 9.0)

$$E = kQ/r^2 = 8.99 \times 10^9 \times 10^{-9} / 1 = 8.99 \text{ V/m.}$$

Q8. Answer: (A) attractive

Parallel currents in the same direction attract; opposite directions repel.

Q9. Answer: (B) linear and time-variant

Scaling and superposition hold, so it is linear. A delayed input $x(t - t_0)$ gives $x(2t - t_0)$, but the delayed output is $x(2t - 2t_0)$, so it is time-variant.

Q10. Answer: 24

Periods are $2\pi/(\pi/4) = 8$ and $2\pi/(\pi/6) = 12$. $\text{LCM}(8, 12) = 24$.

Q11. Answer: 50

$$f = PN/120 = 6 \times 1000/120 = 50 \text{ Hz.}$$

Q12. Answer: 950

$$E_{b1} = 220 - 40 \times 0.5 = 200 \text{ V; } E_{b2} = 220 - 60 \times 0.5 = 190 \text{ V. } N_2 = 1000 \times 190/200 = 950 \text{ rpm.}$$

Q13. Answer: 400

$$\text{SIL} = V^2/Z_c = (400 \text{ kV})^2/400 \Omega = 400 \text{ MW.}$$

Q14. Answer: (A) 30°

$$P = (EV/X) \sin \delta \text{ gives } 1.0 = (1.2 \times 1.0/0.6) \sin \delta = 2 \sin \delta, \text{ so } \delta = 30^\circ.$$

Q15. Answer: 0.25

$$K_v = \lim_{s \rightarrow 0} sG(s) = 20/5 = 4. e_{ss} = 1/K_v = 0.25.$$

Q16. Answer: (A) 60°, 180°, 300°

$$\theta = (2k + 1)180^\circ/(P - Z) = (2k + 1) \times 60^\circ \text{ for } k = 0, 1, 2.$$

Q17. Answer: 0.100 (accept 0.099 to 0.101)

$$R_{sh} = I_m R_m / (I - I_m) = (0.001 \times 100)/0.999 = 0.1001 \Omega.$$

Q18. Answer: (B) 4

$$2^3 = 8 < 12 \leq 16 = 2^4, \text{ so 4 flip-flops are needed.}$$

Q19. Answer: 8

$$I_B = (12 - 0.7)/565k = 20 \mu\text{A}; I_C = 100 \times 20 \mu\text{A} = 2 \text{ mA. } V_{CE} = 12 - 2 \text{ mA} \times 2 \text{ k}\Omega = 8 \text{ V.}$$

Q20. Answer: (B), (C)

An SCR can be turned on by the gate but not turned off by it; a diode has no gate. IGBTs and MOSFETs are fully controllable.

Set 3: Questions

20 questions · 30 marks · 45 minutes

General Aptitude

Q1. [MCQ, 1 mark] Doctor : Hospital :: Teacher : ?

- (A) School
- (B) Book
- (C) Student
- (D) Chalk

Q2. [NAT, 2 marks] The average of five numbers is 20. When one number is removed, the average of the remaining four becomes 18. The number removed is _____.

Engineering Mathematics

Q3. [MCQ, 1 mark] The value of $\lim_{x \rightarrow 0} \sin(3x)/x$ is

- (A) 0
- (B) 1
- (C) 3
- (D) ∞

Q4. [NAT, 2 marks] A box contains 4 red and 6 blue balls. Two balls are drawn at random without replacement. The probability that both are red is _____ (rounded to three decimal places).

Electric Circuits

Q5. [NAT, 1 mark] A voltage $v(t) = 100 \sin(\omega t)$ V is applied across an impedance $Z = 10 \angle 60^\circ \Omega$. The average power absorbed is _____ W.

Q6. [NAT, 2 marks] A T-network has series arms of 2Ω (port 1 side) and 3Ω (port 2 side) and a shunt arm of 5Ω . The value of $\Delta z = z_{11}z_{22} - z_{12}z_{21}$ is _____ Ω^2 .

Electromagnetic Fields

Q7. [MCQ, 1 mark] The SI unit of magnetic flux density is

- (A) Wb
- (B) Wb/m^2
- (C) A/m
- (D) H/m

Q8. [NAT, 1 mark] An air-cored solenoid has 500 turns, length 0.5 m and cross-sectional area 10 cm^2 . Its inductance is _____ mH (rounded to three decimal places).

Signals and Systems

Q9. [NAT, 2 marks] For $x[n] = \{1, 2, 3\}$ and $h[n] = \{1, 1\}$, both starting at $n = 0$, the value of the convolution $y[n] = x[n] * h[n]$ at $n = 2$ is _____.

Q10. [MCQ, 1 mark] The Laplace transform of $e^{-2t}u(t)$ is

- (A) $1/(s + 2)$, $\text{Re}(s) > -2$
- (B) $1/(s - 2)$, $\text{Re}(s) > 2$
- (C) $1/(s + 2)$, $\text{Re}(s) < -2$
- (D) $s/(s + 2)$, $\text{Re}(s) > -2$

Electrical Machines

Q11. [MCQ, 1 mark] In a three-phase induction motor, the maximum torque is independent of

- (A) rotor resistance
- (B) supply voltage
- (C) rotor reactance
- (D) supply frequency

Q12. [NAT, 2 marks] A 20 kVA transformer has iron loss 300 W and full-load copper loss 600 W. Its efficiency at half load and unity power factor is _____ % (rounded to one decimal place).

Power Systems

Q13. [NAT, 2 marks] Two generators have incremental costs $IC_1 = 0.02P_1 + 10$ and $IC_2 = 0.03P_2 + 8$ (Rs/MWh, P in MW). For a total load of 300 MW, neglecting losses, the economic output of generator 1 is _____ MW.

Q14. [MCQ, 1 mark] A Buchholz relay is used to protect

- (A) oil-immersed transformers
- (B) alternators
- (C) transmission lines
- (D) busbars

Control Systems

Q15. [MCQ, 2 marks] A second-order system has $\zeta = 0.6$ and $\omega_n = 10$ rad/s. Its peak overshoot for a step input is approximately

- (A) 9.5%
- (B) 25%
- (C) 1.5%
- (D) 16.3%

Q16. [NAT, 2 marks] For $G(s)H(s) = 3 / [s(s + 1)(s + 2)]$, the gain margin (as a ratio, not in dB) is _____.

Electrical & Electronic Measurements

Q17. [MCQ, 1 mark] A megger is used to measure

- (A) insulation resistance
- (B) low resistance
- (C) inductance
- (D) earth current

Analog and Digital Electronics

Q18. [NAT, 2 marks] An 8-bit DAC has a full-scale output of 10.2 V for input 11111111. The output for input 10010110 is _____ V.

Q19. [MSQ, 1 mark] Which of the following are universal gates?

- (A) AND
- (B) NAND
- (C) NOR
- (D) XOR

Power Electronics

Q20. [NAT, 2 marks] An ideal buck converter has $V_{in} = 48$ V, $V_o = 12$ V, switching frequency 20 kHz and $L = 1$ mH. The peak-to-peak inductor current ripple is _____ A.

Set 3: Answer Key and Solutions

Q	Type	Marks	Answer
1	MCQ	1	(A) School
2	NAT	2	28
3	MCQ	1	(C) 3
4	NAT	2	0.133 (accept 0.13 to 0.14)
5	NAT	1	250
6	NAT	2	31
7	MCQ	1	(B) Wb/m ²
8	NAT	1	0.628 (accept 0.62 to 0.64)
9	NAT	2	5
10	MCQ	1	(A) $1/(s + 2)$, $\text{Re}(s) > -2$
11	MCQ	1	(A) rotor resistance
12	NAT	2	95.7 (accept 95.6 to 95.8)
13	NAT	2	140
14	MCQ	1	(A) oil-immersed transformers
15	MCQ	2	(A) 9.5%
16	NAT	2	2
17	MCQ	1	(A) insulation resistance
18	NAT	2	6
19	MSQ	1	(B), (C)
20	NAT	2	0.45

Worked solutions

Q1. Answer: (A) School

The relation is person : place of work.

Q2. Answer: 28

Sum of five = 100; sum of four = 72; removed number = 28.

Q3. Answer: (C) 3

$\sin(3x)/x = 3 \times \sin(3x)/(3x)$, which tends to $3 \times 1 = 3$.

Q4. Answer: 0.133 (accept 0.13 to 0.14)

$P = (4/10) \times (3/9) = 12/90 = 0.133$.

Q5. Answer: 250

$V_{\text{rms}} = 70.71 \text{ V}$; $I_{\text{rms}} = 7.071 \text{ A}$. $P = V_{\text{rms}} I_{\text{rms}} \cos 60^\circ = 500 \times 0.5 = 250 \text{ W}$.

Q6. Answer: 31

$z_{11} = 2 + 5 = 7$, $z_{22} = 3 + 5 = 8$, $z_{12} = z_{21} = 5$. $\Delta z = 56 - 25 = 31$.

Q7. Answer: (B) Wb/m^2

Magnetic flux density B is measured in tesla, which equals Wb/m^2 .

Q8. Answer: 0.628 (accept 0.62 to 0.64)

$$L = \mu_0 N^2 A / l = 4\pi \times 10^{-7} \times 250000 \times 10^{-3} / 0.5 = 0.628 \text{ mH}.$$

Q9. Answer: 5

$$y[2] = x[2]h[0] + x[1]h[1] = 3 + 2 = 5.$$

Q10. Answer: (A) $1/(s + 2)$, $\text{Re}(s) > -2$

Standard pair: $e^{-at}u(t) \leftrightarrow 1/(s + a)$ with ROC $\text{Re}(s) > -a$.

Q11. Answer: (A) rotor resistance

$T_{\max} \propto V^2 / (2X_2)$. Rotor resistance changes only the slip at which $T_{\max}$ occurs.

Q12. Answer: 95.7 (accept 95.6 to 95.8)

Output = 10 kW. Copper loss at half load = $600 \times 0.25 = 150 \text{ W}$. $\eta = 10000 / (10000 + 300 + 150) = 95.7\%$.

Q13. Answer: 140

Equal incremental cost: $0.02P_1 + 10 = 0.03(300 - P_1) + 8$, so $0.05P_1 = 7$, $P_1 = 140 \text{ MW}$ ($P_2 = 160 \text{ MW}$).

Q14. Answer: (A) oil-immersed transformers

It detects gas produced by internal faults in oil-filled transformers.

Q15. Answer: (A) 9.5%

$$M_p = \exp(-\pi\zeta/\sqrt{1 - \zeta^2}) = \exp(-\pi \times 0.6/0.8) = 0.0948.$$

Q16. Answer: 2

Phase crossover ($\angle G = -180^\circ$) occurs at $\omega = \sqrt{2} \text{ rad/s}$. $|G|$ there = $3/(\sqrt{2} \times \sqrt{3} \times \sqrt{6}) = 0.5$, so $\text{GM} = 1/0.5 = 2$.

Q17. Answer: (A) insulation resistance

A megger applies a high DC voltage to measure very high (insulation) resistance.

Q18. Answer: 6

Resolution = $10.2/255 = 0.04 \text{ V}$. $(10010110)_2 = 150$, so output = $150 \times 0.04 = 6.0 \text{ V}$.

Q19. Answer: (B), (C)

Any Boolean function can be built using only NAND or only NOR gates.

Q20. Answer: 0.45

$$D = 12/48 = 0.25. \Delta I = (V_{in} - V_o)D/(fL) = 36 \times 0.25/(20000 \times 0.001) = 0.45 \text{ A}.$$

Set 4: Questions

20 questions · 30 marks · 45 minutes

General Aptitude

Q1. [MCQ, 1 mark] Choose the word closest in meaning to **CANDID**.

- (A) Frank
- (B) Secretive
- (C) Rude
- (D) Shy

Q2. [NAT, 2 marks] A train 150 m long running at 54 km/h crosses a platform 300 m long. The time taken is _____ seconds.

Engineering Mathematics

Q3. [MCQ, 1 mark] The divergence of $F = x^2 \mathbf{i} + y^2 \mathbf{j} + z^2 \mathbf{k}$ at the point (1, 1, 1) is

- (A) 3
- (B) 6
- (C) 0
- (D) 9

Q4. [NAT, 2 marks] A random variable X follows a Poisson distribution with mean 2. $P(X = 0)$ is _____ (rounded to three decimal places).

Electric Circuits

Q5. [MCQ, 1 mark] In a balanced star-connected three-phase system, the line voltage is 400 V. The phase voltage is

- (A) 400 V
- (B) 230.9 V
- (C) 692.8 V
- (D) 133.3 V

Q6. [NAT, 2 marks] A 10 V source in series with 5Ω feeds node X. A 2 A current source also injects current into node X, and a 5Ω resistor connects X to ground. The voltage at node X is _____ V.

Electromagnetic Fields

Q7. [NAT, 2 marks] An infinite line charge of 1 nC/m lies in free space. The electric field at a distance of 0.5 m is _____ V/m (rounded to one decimal place).

Q8. [MCQ, 1 mark] Lenz's law is a consequence of the law of conservation of

- (A) charge
- (B) energy
- (C) momentum
- (D) mass

Signals and Systems

Q9. [MCQ, 1 mark] The Fourier transform of the unit impulse $\delta(t)$ is

- (A) 1
- (B) $\delta(\omega)$
- (C) $1/(j\omega)$
- (D) $2\pi\delta(\omega)$

Q10. [NAT, 2 marks] A causal sequence has Z-transform $X(z) = z/(z - 0.5)$. The value of $x[3]$ is _____.

Electrical Machines

Q11. [MCQ, 1 mark] The open-circuit (no-load) test on a transformer is mainly used to determine

- (A) core loss
- (B) full-load copper loss
- (C) winding resistance
- (D) leakage reactance

Q12. [NAT, 2 marks] An induction motor develops a starting torque of 1.8 times full-load torque with direct-on-line starting. With a star-delta starter, the starting torque as a multiple of full-load torque is _____.

Power Systems

Q13. [MCQ, 1 mark] For a short transmission line represented by ABCD parameters, the value of C is

- (A) 0
- (B) 1
- (C) Z
- (D) Y

Q14. [NAT, 2 marks] In a 3-disc suspension insulator string, the voltages across the discs are 8 kV, 9 kV and 11 kV. The string efficiency is _____ % (rounded to one decimal place).

Control Systems

Q15. [NAT, 1 mark] A unity-feedback system has $G(s) = 10 / [(s + 1)(s + 2)]$. The steady-state error for a unit step input is _____ (rounded to three decimal places).

Q16. [MCQ, 2 marks] A lead compensator $C(s) = (1 + 0.1s)/(1 + 0.01s)$ provides a maximum phase lead of approximately

- (A) 54.9°
- (B) 45.0°
- (C) 35.1°
- (D) 64.8°

Electrical & Electronic Measurements

Q17. [NAT, 2 marks] An energy meter has a constant of 600 rev/kWh. It supplies a load of 230 V, 10 A at unity power factor for 1 hour. The number of revolutions made is _____.

Analog and Digital Electronics

Q18. [MCQ, 1 mark] An ideal op-amp integrator has $R = 10 \text{ k}\Omega$ and $C = 1 \text{ }\mu\text{F}$, with zero initial output. For a 1 V DC input, the output after 10 ms is

- (A) -1 V
- (B) $+1 \text{ V}$
- (C) -10 V
- (D) -0.1 V

Q19. [NAT, 2 marks] A Zener regulator has $V_{\text{in}} = 20 \text{ V}$, series resistor $200 \text{ }\Omega$, $V_Z = 10 \text{ V}$ and load $500 \text{ }\Omega$. The Zener current is _____ mA.

Power Electronics

Q20. [NAT, 1 mark] A three-phase full-wave uncontrolled (diode) bridge rectifier is fed from 415 V (line, rms). The average output voltage is _____ V (rounded to one decimal place).

Set 4: Answer Key and Solutions

Q	Type	Marks	Answer
1	MCQ	1	(A) Frank
2	NAT	2	30
3	MCQ	1	(B) 6
4	NAT	2	0.135 (accept 0.13 to 0.14)
5	MCQ	1	(B) 230.9 V
6	NAT	2	10
7	NAT	2	36.0 (accept 35.5 to 36.5)
8	MCQ	1	(B) energy
9	MCQ	1	(A) 1
10	NAT	2	0.125
11	MCQ	1	(A) core loss
12	NAT	2	0.6
13	MCQ	1	(A) 0
14	NAT	2	84.8 (accept 84.5 to 85.2)
15	NAT	1	0.167 (accept 0.16 to 0.17)
16	MCQ	2	(A) 54.9°
17	NAT	2	1380
18	MCQ	1	(A) -1 V
19	NAT	2	30
20	NAT	1	560.4 (accept 559 to 562)

Worked solutions

Q1. Answer: (A) Frank

Candid means open and honest.

Q2. Answer: 30

Speed = $54 \times 5/18 = 15$ m/s. Distance = $150 + 300 = 450$ m. Time = 30 s.

Q3. Answer: (B) 6

$\nabla \cdot \mathbf{F} = 2x + 2y + 2z = 6$ at (1, 1, 1).

Q4. Answer: 0.135 (accept 0.13 to 0.14)

$P(X = 0) = e^{-\lambda} = e^{-2} = 0.135$.

Q5. Answer: (B) 230.9 V

$V_{ph} = V_L/\sqrt{3} = 400/1.732 = 230.9$ V.

Q6. Answer: 10

KCL at X: $(V - 10)/5 + V/5 = 2$, so $2V - 10 = 10$ and $V = 10$ V.

Q7. Answer: 36.0 (accept 35.5 to 36.5)

$$E = \lambda / (2\pi\epsilon_0 r) = 10^{-9} / (2\pi \times 8.854 \times 10^{-12} \times 0.5) = 35.95 \text{ V/m.}$$

Q8. Answer: (B) energy

The induced current opposes its cause; otherwise energy would be created without work.

Q9. Answer: (A) 1

$$\int \delta(t) e^{-j\omega t} dt = e^0 = 1 \text{ for all } \omega.$$

Q10. Answer: 0.125

$$x[n] = (0.5)^n u[n], \text{ so } x[3] = 0.125.$$

Q11. Answer: (A) core loss

At rated voltage with no load, copper loss is negligible, so the wattmeter reads core loss.

Q12. Answer: 0.6

Star-delta reduces phase voltage by $1/\sqrt{3}$, so torque falls to $1/3$: $1.8/3 = 0.6$.

Q13. Answer: (A) 0

Shunt admittance is neglected in a short line, so $A = D = 1$, $B = Z$ and $C = 0$.

Q14. Answer: 84.8 (accept 84.5 to 85.2)

$$\eta = V_{\text{total}} / (n \times V_{\text{max}}) = 28 / (3 \times 11) = 84.8\%.$$

Q15. Answer: 0.167 (accept 0.16 to 0.17)

$$K_p = G(0) = 5. \quad e_{ss} = 1 / (1 + K_p) = 1/6 = 0.167.$$

Q16. Answer: (A) 54.9°

$$\alpha = 0.01/0.1 = 0.1. \quad \phi_m = \sin^{-1}[(1 - \alpha)/(1 + \alpha)] = \sin^{-1}(0.818) = 54.9^\circ.$$

Q17. Answer: 1380

$$\text{Energy} = 230 \times 10 \times 1 = 2.3 \text{ kWh.} \quad \text{Revolutions} = 2.3 \times 600 = 1380.$$

Q18. Answer: (A) -1 V

$$v_o = -(1/RC) \int v_{in} dt = -(1/0.01) \times 1 \times 0.01 = -1 \text{ V.}$$

Q19. Answer: 30

$$I_s = (20 - 10)/200 = 50 \text{ mA; } I_L = 10/500 = 20 \text{ mA; } I_Z = 50 - 20 = 30 \text{ mA.}$$

Q20. Answer: 560.4 (accept 559 to 562)

$$V_o = (3\sqrt{2}/\pi)V_{LL} = 1.35 \times 415 = 560.4 \text{ V.}$$

Set 5: Questions

20 questions · 30 marks · 45 minutes

General Aptitude

- Q1.** [MCQ, 1 mark] Fill in the blank: "Neither the teacher nor the students _____ present."
(A) was
(B) were
(C) is
(D) has been
- Q2.** [NAT, 2 marks] A can finish a job in 10 days and B in 15 days. Working together, they finish it in _____ days.

Engineering Mathematics

- Q3.** [MCQ, 1 mark] The system $x + y = 2$, $2x + 2y = 5$ has
(A) a unique solution
(B) no solution
(C) infinitely many solutions
(D) exactly two solutions
- Q4.** [NAT, 2 marks] The value of the double integral $\int_0^1 \int_0^x xy \, dy \, dx$ is _____.

Electric Circuits

- Q5.** [NAT, 1 mark] The energy stored in a $10 \, \mu\text{F}$ capacitor charged to $100 \, \text{V}$ is _____ J.
- Q6.** [MCQ, 2 marks] A parallel RLC circuit has $R = 100 \, \Omega$, $L = 1 \, \text{mH}$ and $C = 10 \, \mu\text{F}$. Its resonant frequency and quality factor are
(A) $1591.5 \, \text{Hz}$, $Q = 10$
(B) $1591.5 \, \text{Hz}$, $Q = 0.1$
(C) $10000 \, \text{Hz}$, $Q = 10$
(D) $159.2 \, \text{Hz}$, $Q = 10$

Electromagnetic Fields

- Q7.** [NAT, 2 marks] A conductor $0.2 \, \text{m}$ long carrying $10 \, \text{A}$ is placed in a uniform field of $0.5 \, \text{T}$ at 30° to the field. The force on it is _____ N.
- Q8.** [MCQ, 1 mark] At a charge-free boundary between two perfect dielectrics, which quantities are continuous?
(A) Tangential E and normal D
(B) Normal E and tangential D
(C) Normal E only
(D) Tangential D only

Signals and Systems

- Q9.** [NAT, 1 mark] The energy of the signal $x(t) = e^{-2t}u(t)$ is _____.

- Q10.** [MCQ, 2 marks] An LTI system has $H(s) = 1/(s - 1)$ with ROC $\text{Re}(s) < 1$. The system is
- (A) causal and stable
 - (B) non-causal and stable
 - (C) causal and unstable
 - (D) non-causal and unstable

Electrical Machines

- Q11.** [NAT, 1 mark] The synchronous speed of an 8-pole, 60 Hz motor is _____ rpm.
- Q12.** [NAT, 2 marks] A 4-pole lap-wound DC generator has 500 conductors and flux 0.02 Wb per pole and runs at 1200 rpm. The generated EMF is _____ V.

Power Systems

- Q13.** [MCQ, 1 mark] The Ferranti effect in long transmission lines refers to
- (A) receiving-end voltage exceeding sending-end voltage at light or no load
 - (B) corona loss at high voltage
 - (C) skin effect at high frequency
 - (D) voltage drop due to inductive load
- Q14.** [NAT, 2 marks] In a three-phase system, the line currents are $I_a = 10\angle 0^\circ$ A, $I_b = 0$ and $I_c = 0$. The magnitude of the zero-sequence current is _____ A (rounded to two decimal places).

Control Systems

- Q15.** [MCQ, 1 mark] Adding a PI controller in cascade with a type-0 plant
- (A) eliminates steady-state error for a step input
 - (B) reduces the system type
 - (C) eliminates error for a parabolic input
 - (D) always improves transient response
- Q16.** [NAT, 2 marks] A system has state matrix $A = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}$. Its undamped natural frequency is _____ rad/s (rounded to two decimal places).

Electrical & Electronic Measurements

- Q17.** [MCQ, 1 mark] A Lissajous pattern on a CRO touches 3 horizontal tangent lines and 2 vertical tangent lines. If the horizontal-plate frequency is 100 Hz, the vertical-plate frequency is
- (A) 150 Hz
 - (B) 66.7 Hz
 - (C) 300 Hz
 - (D) 200 Hz

Analog and Digital Electronics

- Q18.** [NAT, 1 mark] The decimal equivalent of $(1101.101)_2$ is _____.

Q19. [MSQ, 2 marks] Which of the following are effects of negative feedback in an amplifier?

- (A) Bandwidth increases
- (B) Gain becomes more stable
- (C) Gain increases
- (D) Distortion decreases

Power Electronics

Q20. [NAT, 2 marks] A single-phase full-bridge inverter operates in square-wave mode from a 220 V DC source. The rms value of the fundamental output voltage is _____ V.

Set 5: Answer Key and Solutions

Q	Type	Marks	Answer
1	MCQ	1	(B) were
2	NAT	2	6
3	MCQ	1	(B) no solution
4	NAT	2	0.125
5	NAT	1	0.05
6	MCQ	2	(A) 1591.5 Hz, $Q = 10$
7	NAT	2	0.5
8	MCQ	1	(A) Tangential E and normal D
9	NAT	1	0.25
10	MCQ	2	(B) non-causal and stable
11	NAT	1	900
12	NAT	2	200
13	MCQ	1	(A) receiving-end voltage exceeding sending-end voltage at light or no load
14	NAT	2	3.33 (accept 3.3 to 3.4)
15	MCQ	1	(A) eliminates steady-state error for a step input
16	NAT	2	2.45 (accept 2.44 to 2.46)
17	MCQ	1	(A) 150 Hz
18	NAT	1	13.625
19	MSQ	2	(A), (B), (D)
20	NAT	2	198 (accept 197 to 199)

Worked solutions

Q1. Answer: (B) were

With neither/nor, the verb agrees with the nearer subject (students, plural).

Q2. Answer: 6

Combined rate = $1/10 + 1/15 = 1/6$ per day, so 6 days.

Q3. Answer: (B) no solution

The left sides are proportional (ratio 2) but the right sides are not ($5 \neq 4$), so the equations are inconsistent.

Q4. Answer: 0.125

Inner integral = $x \times x^2/2 = x^3/2$. $\int_0^1 x^3/2 \, dx = 1/8$.

Q5. Answer: 0.05

$W = \frac{1}{2}CV^2 = 0.5 \times 10^{-5} \times 10^4 = 0.05 \text{ J}$.

Q6. Answer: (A) 1591.5 Hz, Q = 10

$$f_0 = 1/(2\pi\sqrt{LC}) = 1591.5 \text{ Hz. For parallel RLC, } Q = R\sqrt{C/L} = 100 \times 0.1 = 10.$$

Q7. Answer: 0.5

$$F = BIl \sin \theta = 0.5 \times 10 \times 0.2 \times 0.5 = 0.5 \text{ N.}$$

Q8. Answer: (A) Tangential E and normal D

$$E_{t1} = E_{t2} \text{ always; } D_{n1} - D_{n2} = \rho_s = 0.$$

Q9. Answer: 0.25

$$E = \int_0^\infty e^{-4t} dt = 1/4.$$

Q10. Answer: (B) non-causal and stable

The ROC lies to the left of the pole, so the system is anti-causal. It includes the $j\omega$ axis, so it is stable.

Q11. Answer: 900

$$N_s = 120f/P = 120 \times 60/8 = 900 \text{ rpm.}$$

Q12. Answer: 200

$$E = P\phi ZN/(60A). \text{ For lap winding } A = P = 4: E = 0.02 \times 500 \times 1200/60 = 200 \text{ V.}$$

Q13. Answer: (A) receiving-end voltage exceeding sending-end voltage at light or no load

Line charging current through series inductance raises the receiving-end voltage.

Q14. Answer: 3.33 (accept 3.3 to 3.4)

$$I_0 = (I_a + I_b + I_c)/3 = 10/3 = 3.33 \text{ A.}$$

Q15. Answer: (A) eliminates steady-state error for a step input

The integrator adds a pole at the origin, raising the system type to 1.

Q16. Answer: 2.45 (accept 2.44 to 2.46)

$$\text{Characteristic equation: } s^2 + 5s + 6 = 0, \text{ so } \omega_n = \sqrt{6} = 2.45 \text{ rad/s.}$$

Q17. Answer: (A) 150 Hz

$$f_y/f_x = (\text{horizontal tangencies})/(\text{vertical tangencies}) = 3/2, \text{ so } f_y = 150 \text{ Hz.}$$

Q18. Answer: 13.625

$$1101 = 13 \text{ and } .101 = 0.5 + 0.125 = 0.625.$$

Q19. Answer: (A), (B), (D)

Negative feedback trades gain for bandwidth, stability and lower distortion. Gain decreases.

Q20. Answer: 198 (accept 197 to 199)

$$V_{1,\text{rms}} = 4V_{\text{dc}}/(\pi\sqrt{2}) = 0.9 \times 220 = 198 \text{ V.}$$