UPPSC-AE 2025

UTTAR PRADESH PUBLIC SERVICE COMMISSION

Combined State Engineering
Services Examination

Assistant Engineer

Electrical Engineering

Previous Years Solved Papers

Objective Papers

General Hindi

General Studies

Practice Questions

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UPPSC-AE : Electrical Engineering Previous Solved Papers

First Edition: 2020
Second Edition: 2021
Third Edition: 2022
Reprint: 2023
Reprint: 2024

Reprint: 2025

Preface

B. Singh (Ex. IES)

UPPSC Assistant Engineer Examination has been always preferred by Engineers due to job stability and opportunity to work in home sate. UPPSC Combined State Engineering Services examination is conducted time to time but not every year. MADE EASY team has made deep study of previous exam papers and observed that a good percentage of questions are of repetitive in nature, therefore previous year's papers are advisable to solve before a candidate takes the exam. This book is also useful for MP State Engineering Services, UPSC Engineering Services and other Competitive exams for Engineering graduates.

The current edition of this book contains complete solutions to all questions with accuracy. I have true desire to serve student community by providing good source of study and quality guidance. I hope this book will be proved an important tool to succeed in UPPSC and other competitive exams. Any suggestions from the readers for improvement of this book are most welcome.

With Best Wishes

B. Singh

CMD, MADE EASY

UPPSC : Exam Pattern

Combined State Engineering Services Examination
Assistant Engineer examination

Paper I : Objective **Maximum Time : 2½ Hours • Maximum Marks : 375** Each question carries 3 marks. There is a penalty of –1 mark for every wrong attempted answer	
General Hindi	25 Questions
Technical Paper I	100 Questions
Total	**125 Questions** (375 Marks)

Paper II : Objective **Maximum Time : 2½ Hours • Maximum Marks : 375** Each question carries 3 marks. There is a penalty of –1 mark for every wrong attempted answer	
General Studies	25 Questions
Technical Paper II	100 Questions
Total	**125 Questions** (375 Marks)

Uttar Pradesh Public Service Commission
Combined State Engineering Services Examination
Assistant Engineer
Electrical Engineering

Paper-I

Networks and Systems :
Steady-state and Transient-state Analysis of systems, Thevenin's- Norton's-, Superposition- and Maximum Power Transfer theorems, Driving point transfer functions, Two-port networks, Laplace and Fourier transforms and their applications in network analysis, Z-transforms for discrete systems, R-L, R-C & L-C network synthesis.

E.M. Theory :
Analysis of electrostatic and magnetostatic fields, Laplace, Poission and Maxwell equations, Solution of boundary value problems, electromagnetic wave propagation, Ground and space waves, Propagation between Earth Station and Satellites.

Control Systems :
Mathematical modelling of dynamic linear continuous systems, Block diagrams and signal flow graphs, time-response specifications, steady-state error, Routh-Hurwitz criterion, Nyquist techniques, Root Loci, Bode Plots, Polar Plot and stability analysis, Lag-, Lead-, Lag-Lead compensation, state-space modelling, state transition matrix, controllability and observability.

Elements of Electronics :
Basics of semiconductor diodes, BJT, FET and their characteristics, different types of transistors and FET amplifiers equivalent circuits and frequency response, feedback oscillators, colpitts oscillator and Hartley Oscillator, Operational amplifiers-characteistic and applications.

Power System Analysis and Design :
Line parameters and calculations, Performance of transmission lines, Mechanical design of overhead lines and insulators, Corona radio interference parameters of single- and three-core cables, Bus admittance matrix, Load flow equations and methods of solutions, Fast-decoupled load flow, Balance- and unbalanced-faults analysis, Power system stability, Power system transients and travailing waves, EHV transmission, HVDC transmission, Concepts of FACTS, Voltage control and economic operation, Concepts of distributed generation, solar and wind power, smart grid conclepts.

Elements of Electrical Machines :
General concepts of e.m.f., m.m.f. and torque in rotating machines, DC machines: motor and generator characteristics, equivalent circuits, commutation and amature reaction, starting and speed controls of motors; Synchronous machines: performance, regulation, parallel operation of generators, motor starting, characteristics and applications, Transformers: phasor-diagram and equivalent circuit, efficiency and voltage regulation, auto-transformers, 3-phase transformers.

Measurement :
Basic methods of measurement, Precision and standards, error analysis, Bridges and Poteniometers; moving coil, moving iron, dynamometer and induction type instruments, measurement of voltage, current, power, energy, and power factor, instrument transformers, digital voltmeters and multimeters, phase-, time- and frequency-measurement, Q-meters oscilloscopes, Basics of sensors and data acquisition system, instrumentation systems for pressure and temperature measurements.

Paper-II

Power Electronics and Drives :

Semiconductor, power, diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs static characteristics and principles of operation, triggering circuits single phase and three-phase controlled rectifiers-fully controlled and half controlled, smoothing and filters regulated power supplies, DC-DC choppers and inverters, speed control circuits for DC and AC drives, Basics of electric drives: types, quadrant operation, revesing and braking of electric motors, estimation of power ratings, traction motors.

Digital Electronics :
Boolean algebra, logic gates, combinational and sequential logic circuits, multiplexers, multivibrators, sample and hold circuits, A/D and D/A converters, basics of filter circuits and applications, active filters, semiconductor memories.

Microwaves and Communication Systems : Electromagnetic wave in guided media, wave guide components, resonators, microwave tubes, microwave generators and amplifiers.

Analog Communication Basic :

Modulation and demodulation, noise and bandwidth, transmitters and receivers, signal to noise ratio, digital communication basics, sampling, quantizing, coding frequency- and time-domain multiplexing, sound and vision broadcast, antennas, transmission lines at audio and ultra-high frequencies.

Induction and special Machines :

Three-phase induction motors rotating magnetic field, torque-slip characteristics, Equivalent circuit and determination of its parameters, starters, speed control, Induction generators, Single phase induction motors; theory and phasor diagrams, characteristics, starting and applications, repulsion motor, series motor: e.m.f. equation and phasor diagram and performance, servomotors, stepper motors, reluctance motors, brushless DC motors (BLDC).

Power System Protection and Switch Gear :

Methods of Arc Extinction, Restriking voltages and recovery voltage, testing of circuit breakers, Protective relays, protective schemes for power system equipment, surges in transmission lines and protection.

Numerical Methods :

Solution of non-linear algebraic equations, single and multisteps methods for solution of differential equations.

Electrical Engineering Materials :

Crystal structure and defects, conducting, insulating and magneting materials, super-conductors.

Elements of Microprocessors :

Data representation and representation of integer and floating point-numbers. Organization and programming of a microprocessor, ROM and RAM memories CPU of a microcomputer, interfacing memory and I/O devices, Programmable peripheral and communication interface. Application of microprocessors.

Contents

Electrical Engineering

Section-A :

Section-B :

Section-C :

Section-D :

■■■■

Note: The UPPSC-AE exam was not conducted in 2023 and 2024. The most recent exam, notified in 2021, was held on May 29, 2022. This book includes solutions to all previous exam papers up to the last conducted examination (in 2022).

UPPSC-AE

Combined State Engineering
Services Examination

Section-A

Electrical Engineering

Objective Previous Years Questions

UPPSC-AE 2013
Electrical Engineering : Paper-I
(Memory Based)

Q.1 A control system is defined by

$$\frac{d^2x}{dt^2}+\frac{6dx}{dt}+5x=12(1-e^{-2t})$$

The response of system at $t \to \infty$ is

(a) $x = 6$ (b) $x = 2$
(c) $x = 2.4$ (d) $x = -2$

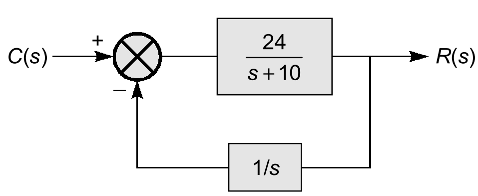
Q.2 The closed loop transfer function of a control system is given by $\frac{C(s)}{R(s)}=\frac{1}{1+s}$. For input $r(t) = \sin t$, the steady value of $C(t)$ is equal to

(a) $\frac{1}{\sqrt{2}}\cos t$ (b) 1
(c) $\frac{1}{\sqrt{2}}\sin t$ (d) $\frac{1}{\sqrt{2}}\sin\left(t-\frac{\pi}{4}\right)$

Q.3 The steady state error due to a step input for type 1 system is

(a) Infinite (b) Negative
(c) Negligible (d) Zero

Q.4 The roots of a closed-loop characteristic equation for the system shown are:



(a) –4, –10 (b) –4, –6
(c) –4, +6 (d) –4, +10

Q.5 The type of the system having transform function $G(s)H(s)=\frac{K}{s^3+2s^2+3s}$ is

(a) 1 (b) 2
(c) 3 (d) 4

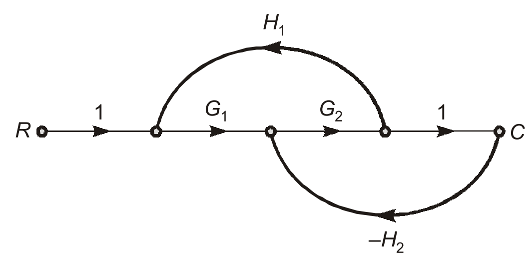
Q.6 The impulse response of the system

$$\frac{C(s)}{R(s)}=\frac{8}{s(s+2)(s+4)}$$

is

(a) $C(t) = 2 - e^{-2t} + e^{-4t}$
(b) $C(t) = 1 + 2e^{-2t} - 4e^{-4t}$
(c) $C(t) = 1 - 2e^{-2t} + e^{-4t}$
(d) $C(t) = 2 + e^{-2t} - 4e^{-4t}$

Q.7 The overall transfer function for the signal flow graph shown is



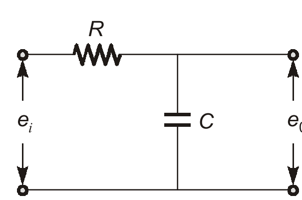
(a) $\frac{G_1G_2}{(1-G_1G_2H_1+G_2H_2)}$

(b) $\frac{G_1G_2}{(1+G_1G_2H_1+G_2H_2)}$

(c) $\frac{G_1G_2}{(1-G_1G_2H_1-G_2H_2)}$

(d) $\frac{G_1G_2}{(1+G_1G_2H_2+G_2H_1)}$

Q.8 The transfer function for the network shown is



(a) $\frac{1}{(RCs+1)}$ (b) $(RCs + 1)$
(c) $\frac{1}{\left(\frac{R}{C}s+1\right)}$ (d) $\left(\frac{R}{C}s+1\right)$

Q.9 The value of function $f(s)=\frac{2}{s^2+3}$ at $t = 0$ is

(a) 3 (b) 2
(c) $\frac{3}{2}$ (d) zero

Q.10 The initial slope of the Bode plot gives an indication of
(a) Nature of the system time response
(b) System stability
(c) Marginally stable
(d) Unstable

Q.11 The value of 'k' at which the root locus crosses the imaginary axis, makes the system
(a) Stable (b) Underdamped
(c) Marginally stable (d) Unstable

Q.12 For the following characteristic equation, the centroid of the root locus plot is $s^3 + 2s + ks + k = 0$
(a) 0.5 (b) –0.5
(c) –1 (d) 1

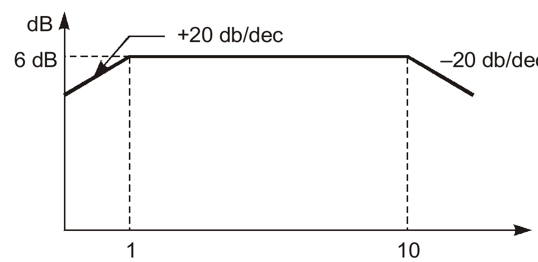
Q.13 The transfer function of a system is $G(s) = \dfrac{s+6}{ks^2+s+6}$. If the damping ratio is unity, the value of k is
(a) $\frac{1}{6}$ (b) $\frac{1}{12}$
(c) $\frac{1}{24}$ (d) $\frac{1}{36}$

Q.14 The state transition matrix e^{AT} for a given matrix
$A = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ is
(a) $\begin{bmatrix} 0 & e^{-t} \\ e^{-t} & 0 \end{bmatrix}$ (b) $\begin{bmatrix} e^{t} & 0 \\ 0 & e^{t} \end{bmatrix}$
(c) $\begin{bmatrix} e^{-t} & 0 \\ 0 & e^{-t} \end{bmatrix}$ (d) $\begin{bmatrix} 0 & e^{t} \\ e^{t} & 0 \end{bmatrix}$

Q.15 Transfer function of a control system is
$$\frac{Y(s)}{U(s)} = \frac{2}{s^3+6s^2+11s+6}$$
the system is,
(a) controllable and observable
(b) controllable but not observable
(c) observable but not controllable
(d) neither controllable nor observable

Q.16 The output of a linear system for a unit step input is given by $t^2 \cdot e^{-t}$. The transfer function of the system will be
(a) $\frac{s}{s(s+1)^3}$ (b) $\frac{2}{s(s+1)^2}$
(c) $\frac{1}{s^2(s+1)}$ (d) $\frac{2s}{s(s+1)^2}$

Q.17 The transfer function of the system whose Bode plot is shown, will be



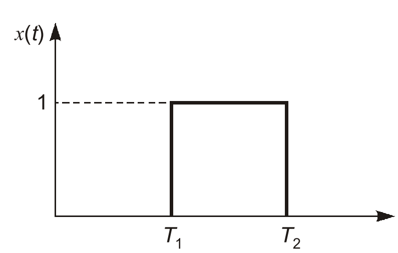
(a) $\frac{10s}{(s+1)(s+10)}$ (b) $\frac{20s}{(s+1)(s+10)}$
(c) $\frac{10}{(s+1)^2(s+10)}$ (d) $\frac{20}{(s+1)(s+10)^2}$

Q.18 The transfer function has its zero in the right half of the s-plane. The function
(a) Is positive real
(b) Will give stable impulse response
(c) Is in minimum phase
(d) Is in non-minimum phase

Q.19 The maximum phase shift that can be provided by a lead compensator with transfer function
$$G(s) = \frac{1+6s}{1+2s}$$
(a) 15° (b) 45°
(c) 30° (d) 60°

Q.20 State space analysis is applicable even if the initial conditions are
(a) zero (b) non zero
(c) equal (d) not equal

Q.21 The Laplace transform of the figure shown, is



(a) $\frac{e^{-ST_1}}{S} - \frac{e^{-ST_2}}{S}$ (b) $\frac{e^{-ST_1}}{S} + \frac{e^{-ST_2}}{S}$

(c) $\frac{e^{-ST_1}}{S^2} - \frac{e^{-ST_2}}{S^2}$ (d) $\frac{e^{-ST_1}}{S^2} + \frac{e^{-ST_2}}{S^2}$

Q.22 In a bode magnitude plot, which one of the following slopes would be exhibited at high frequency by a 4^{th} order all pole system?
(a) –80 db/decade (b) –40 db/decade
(c) –20 db/decade (d) 20 db/decade

Q.23 If open loop transfer function contains one zero in right half of s-place, then
(a) close loop system is unstable
(b) open loop system is unstable
(c) close loop system is unstable for higher gain
(d) close loop system is stable

Q.24 The acceptable band of the settling time 't_s' is
(a) ±20%
(b) 10%
(c) 5%
(d) Both (a) and (c) depending on applications

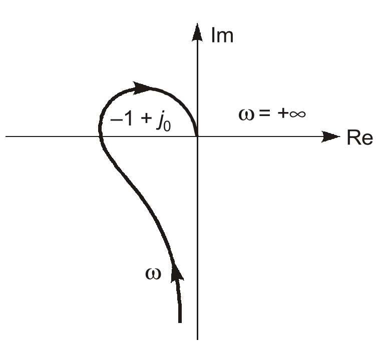
Q.25 A unity feedback system has transfer function

$G(s) = \frac{3}{s^2 + 4s + 9}$, its natural frequency will be

(a) 1 (b) 3
(c) 6 (d) 9

Q.26 The frequency at which the magnitude plot in a Bode plot crosses zero the db line, line is termed as
(a) Natural frequency
(b) Corner frequency
(c) Phase crossover frequency
(d) Gain crossover frequency

Q.27 As observed from the polar plot shown



(a) GM is (+)ve, PM is (+)ve
(b) GM is (–)ve, PM is (–)ve
(c) GM is (–)ve, PM is (+)ve
(d) GM is (+)ve, PM is (–)ve

Q.28 The standard test signal in control system is/are
(a) Impulse signal (b) Ramp signal
(c) Unit step signal (d) All of the above

Q.29 For a second order control system has a transfer function $\frac{16}{s^2 + 4s + 16}$. Find the setting time for 2% tolerance?
(a) 10 sec (b) 5 sec
(c) 4 sec (d) 2 sec

Q.30 The minimum number of states required to describe the two degree differential equation is
(a) 1 (b) 3
(c) 2 (d) 4

Q.31 An unloaded generator with a pre-fault voltage 1 pu has the following sequence impedances: $Z_0 = j0.15$ pu, $Z_1 = Z_2 = j0.25$ pu. The neutral is grounded with a reactance of 0.05 pu. The fault current in pu for a single line to ground fault is
(a) 3.75 pu (b) 4.28 pu
(c) 6.0 pu (d) 7.2 pu

Q.32 If a voltage controller bus is treated as load bus, then which one of the following limits would be violated?
(a) Voltage (b) Active power
(c) Reactive power (d) Phase angle

Q.33 In a short transmission line, resistance and inductance are found to be equal and regulation appears to be zero, then the load will be
(a) unity power factor
(b) zero power factor
(c) 0.707 lagging
(d) 0.707 leading

Q.34 Magnetic field intensity (H) of a long conductor carrying current 'I' at a distance 'r' is

(a) $\frac{I}{4\pi r}$ (b) $\frac{1}{2r}$

(c) $\frac{I}{4r}$ (d) $\frac{I}{2r}$

Answers UPPSC-AE Paper-I : 2013

1. (c)	2. (d)	3. (d)	4. (b)	5. (a)	6. (c)	7. (d)	8. (a)
9. (d)	10. (d)	11. (c)	12. (b)	13. (b)	14. (b)	15. (a)	16. (d)
17. (b)	18. (d)	19. (c)	20. (b)	21. (d)	22. (a)	23. (c)	24. (d)
25. (b)	26. (d)	27. (b)	28. (d)	29. (b)	30. (c)	31. (a)	32. (c)
33. (d)	34. (d)	35. (d)	36. (a)	37. (c)	38. (c)	39. (d)	40. (a)
41. (a)	42. (b)	43. (a)	44. (b)	45. (b)	46. (b)	47. (d)	48. (b)
49. (c)	50. (a)	51. (b)	52. (d)	53. (c)	54. (a)	55. (b)	56. (a)
57. (b)	58. (*)	59. (a)	60. (c)	61. (d)	62. (d)	63. (a)	64. (d)
65. (b)	66. (d)	67. (b)	68. (b)	69. (b)	70. (a)	71. (b)	72. (a)
73. (b)	74. (c)	75. (d)	76. (d)	77. (b)	78. (c)	79. (a)	80. (b)
81. (b)	82. (c)	83. (b)	84. (b)	85. (c)	86. (d)	87. (a)	88. (d)
89. (a)	90. (b)	91. (d)	92. (c)	93. (c)	94. (a)	95. (b)	96. (*)
97. (b)	98. (a)	99. (b)	100. (d)	101. (c)	102. (d)	103. (a)	104. (d)
105. (c)	106. (a)	107. (b)	108. (c)	109. (a)	110. (d)	111. (a)	112. (d)
113. (c)	114. (d)	115. (b)	116. (b)	117. (c)	118. (a)	119. (a)	120. (c)
121. (b)	122. (c)	123. (d)	124. (d)	125. (a)	126. (a)	127. (b)	128. (c)
129. (b)	130. (d)	131. (c)	132. (b)	133. (d)	134. (c)	135. (a)	136. (d)
137. (d)	138. (d)	139. (a)	140. (c)	141. (d)	142. (d)	143. (b)	144. (a)
145. (a)	146. (a)	147. (c)	148. (a)	149. (d)	150. (d)	151. (c)	152. (d)
153. (b)	154. (a)	155. (d)	156. (c)	157. (b)	158. (a)	159. (c)	160. (a)
161. (b)	162. (a)	163. (b)	164. (b)	165. (b)	166. (d)	167. (c)	168. (d)
169. (c)	170. (b)	171. (a)	172. (c)	173. (a)	174. (c)	175. (b)	176. (c)
177. (c)	178. (a)	179. (d)	180. (b)				

Explanations

1. (c)

Given system

$$\frac{d^2x}{dt^2}+\frac{6dx}{dt}+5x = 12(1-e^{-2t})$$

$$s^2x(s) + 6sx(s) + 5x(s) = 12\left(\frac{1}{s}-\frac{1}{s+2}\right)$$

$$x(s)\,(s^2 + 6s + 5) = 12\left(\frac{s+2-s}{s(s+2)}\right)$$

$$x(s) = \frac{24}{s(s+2)(s^2+6s+5)}$$

The response of the system at $t \to \infty$ is

$$\lim_{s\to 0} sx(s) = \lim_{s\to 0} s\times\frac{24}{s(s+2)(s^2+6s+5)}$$

$$= 2.4$$

2. (d)

$$F(s) = \frac{C(s)}{R(s)}=\frac{1}{1+s}=\frac{1}{1+j\omega}$$

$$|F(j\omega)| = \frac{1}{\sqrt{1+\omega^2}}$$

$$\angle(F(j\omega)) = -\tan^{-1}\omega$$

Given, [sin t] = input, $\therefore$ $\omega = 1$

$$|F(j\omega)| = \frac{1}{\sqrt{2}}$$

$$\angle F(j\omega) = -45°$$

Output is therefore $\frac{1}{\sqrt{2}}\sin(t-45°)$

3. (d)

There will be no steady-state error of step input.

4. (b)

$$\frac{C(s)}{R(s)} = \frac{\frac{24}{s+10}}{1+\frac{24}{s(s+10)}}$$

$$\frac{C(s)}{R(s)} = \frac{24s}{s^2+10s+24}$$

Characteristics equation $s^2 + 10s + 24 = 0$

$s^2 + 4s + 6s + 24 = 0$

$s = -4, -6$

5. (a)

Given,

$$G(s)H(s) = \frac{K}{s^3+2s^2+3s}$$

$$= \frac{K}{s(s^3+2s+3)}$$

Hence type of the system is 1.

6. (c)

Given impulse response of the system

$$\frac{C(s)}{R(s)} = \frac{8}{s(s+2)(s+4)}$$

$$= \frac{A}{s}+\frac{B}{(s+2)}+\frac{C}{(s+4)}$$

$$= \frac{A(s+2)(s+4)+Bs(s+4)+Cs(s+2)}{s(s+2)(s+4)}$$

$$= \frac{A(s^2+4s+2s+8)+B(s^2+4s)+C(s^2+2s)}{s(s+2)(s+4)}$$

$$A + B + C = 0$$
$$6A + 4B + 2C = 0$$
$$8A = 8$$
$$A = 1$$
$$B + C = -1$$
$$4B + 2C = -6$$
$$2B + 2C = -2$$
$$- \quad - \quad +$$

$$2B = -4$$
$$B = -2$$
$$A + B + C = 0$$
$$1 - 2 + C = 0$$
$$C = 1$$

$$= \frac{1}{s}-\frac{1}{(s+2)}+\frac{1}{(s+4)}$$

$$= u(t) - 2e^{-2t}u(t) + e^{-4t}u(t)$$

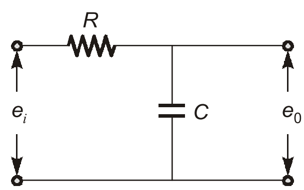
$$= (1 - 2e^{-2t} + e^{-4t})u(t)$$

7. (d)

Over all transfer function

$$= \frac{G_1G_2}{1+G_1G_2H_1+G_2H_1}$$

8. (a)



$$\frac{e_o}{e_i} = \frac{\frac{1}{CS}}{R+\frac{1}{CS}} = \frac{1}{RCS}$$

9. (d)

The value of $f(s) = \dfrac{2}{s^2+3}$ at $t = 0$

$$\lim_{s\to\infty} s\left(\frac{2}{s^2+3}\right) = \lim_{s\to\infty} \frac{2s}{s^2+3} = 0$$

10. (d)

The initial slope at the Bode plot gives type of the system.

11. (c)

The value of k at which the root locus crosses the imaginary axis, make the system marginally stable.

12. (b)

Given characteristics $s^3 + 2s^2 + ks + k = 0$ equation

$$\frac{C(s)}{R(s)} = \frac{k(s+1)}{s^3+2s^2}$$

Number of poles = 3
Number of zeros = 1

$$\sigma = -\frac{2+1}{2} = -0.5$$

13. (b)

Given, $G(s) = \dfrac{s+6}{ks^2+s+6}$

Damping ratio = 1
Characteristics equation

$$= ks^2 + s + 6 + s + 6$$
$$= ks^2 + 2s + 12$$
$$= s^2 + \frac{2}{k}s + \frac{12}{k}$$

$$\omega_n = \sqrt{\frac{12}{k}}$$

$$2\xi\omega_n = \frac{2}{k}$$

$$k = \frac{1}{12}$$

15. (a)

Given transfer function,

$$\frac{Y(s)}{U(s)} = \frac{2}{s^3+6s^2+11s+6}$$

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}U$$

$$y = [0 \quad 0 \quad 2]\,[x]$$

$$A = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}$$

$$B = \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}[0 \;\; 0 \;\; 2]$$

for controllability: $\begin{bmatrix}B & AB & A^2B\end{bmatrix}$

$$C_T = \begin{bmatrix}0 & 0 & 1\\ 0 & 1 & 6\\ 1 & -6 & 102\end{bmatrix} = \text{dat } C_T$$

Hence, controllable.

$|C_T| \neq 0$ controllable

For observability : $\begin{bmatrix}C\\ CA\\ CA^2\end{bmatrix} = \begin{matrix} & 0 & 2\\ 2 & 2 & 0\\ 0 & 12 & 2\end{matrix}$

$|0| \neq 0$ Hence, observable

16. (d)

Output for a unit step input is $t^2 \cdot e^{-t}$

$$Y(t) = t^2 \cdot e^{-t}$$

$$Y(s) = \frac{2}{(s+1)^3}$$

$$X(s) = \frac{1}{s}$$

$$\frac{Y(s)}{X(s)} = \frac{2s}{(s+1)^3}$$

17. (b)

$$20 \log k = 6 \text{ db}$$

$$\log k = \frac{3}{10}$$

$$\Rightarrow \quad 10^{0.3} = k$$

$$T(s) = \frac{20s}{(s+1)(s+10)}$$

18. (d)

Non-minimum phase system transfer function has its zero in the right half of the s-plane.

19. (c)

Given transfer function,

$$G(s) = \frac{1+6s}{1+2s}$$

$$G(s) = \frac{6\left(s+\frac{1}{6}\right)}{2\left(s+\frac{1}{2}\right)} = \frac{3\left(s+\frac{1}{6}\right)}{\left(s+\frac{1}{2}\right)}$$

$$a = \frac{P_c}{z_c} = \frac{1/2}{1/6} = 3$$

Maximum phase shift = $\sin^{-1}\left(\frac{3-1}{3+1}\right) = 30°$

21. (d)

$$u(t-T_1) - u(t-T_2)$$

$$\frac{e^{-ST_1}}{S^2} - \frac{e^{-ST_2}}{S^2}$$

22. (a)

For a 4th or der all pole system slope (–20 db) × 4 = –80 db/decade.

24. (d)

We will use a band to 5% although sometimes 2% are also used.

25. (b)

Using C.E. : $s^2 + 2\xi\omega_n s + \omega_n^2$

$\omega_n^2 = 9, \quad \omega_n = 3$ rad/sec

26. (d)

This is done by calculating the vertical distance between the phase curve (on the bode phase plot) and the x-axis at the frequency where the bode magnitude plot = 0 dB. This point is known as the gain crossover frequency.

27. (b)

This is unstable system, therefore GM as well as PM is (–)ve.

28. (d)

All of the above mentioned signal i.e. impulse, ramp and unit step are used to test dynamic behaviour of control system.

29. (b)

Given transfer function = $\frac{16}{(s^2+4s+16)}$

The standard second order expression in terms of damping ratio (ξ) and natural frequency (ω_n) is as follows

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

Therefore, natural frequency $\omega_n = 4$ rad/sec

Damping ratio $\xi = 0.5$

Setting time for 2% tolerance = $\frac{4}{\xi\omega_n}$

$$= \frac{4}{4 \times 0.5} = 2 \text{ sec}$$

30. (c)

Number of state required for network with n energy storing elements is n.

$\therefore$ For 2 degree equation minimum states required is 2.

31. (a)

Fault current,

$$I_f = \frac{3E_a}{Z_1 + Z_2 + Z_0}$$

$$= \frac{3 \times 1}{j0.25 + j0.25 + j0.15 + j0.15}$$

$$= \frac{3}{j0.80} = -j\,3.75 \text{ pu}$$

32. (c)

If a voltage control bus has its reactive power limits violated, then that bus will be treated as a load bus.

33. (d)

Zero voltage regulation is possible only for leading power factor.

34. (d)

$$B = \frac{\mu_0}{4\pi}\frac{2I}{r}$$

where $H = \dfrac{2I}{4\pi r}$

35. (d)

Sequence impedances of a transmission line

$$z_1 = z_2 = x_s - x_m$$
$$z_0 = x_s + 2x_m$$
$$\therefore \quad z_1 = z_2 < z_0$$

36. (a)

Circular.

37. (c)

The most common conductor in use for transmission today is aluminum conductor steel rein forced (ACSR).

38. (c)

The Kelvin's law states that the most economical size of a conductor is that for which annual interest and depreciation on the capital cost of the conductor is equal to the annual cost of energy loss.

40. (a)

Types of insulators

1. Pin - type insulator
2. Suspension - type insulator
3. Strain-type insulator

41. (a)

The Bipolar link has two conductors one is positive and the other one is negative to the Earth.

42. (b)

For $(m \times m)$ bus if the added element is a branch then the new bus impedance matrix will be of dimensions $(m + 1) \times (m + 1)$.

43. (a)

Good voltage regulation of a distribution network is probably the most important factor responsible for delivering good service to the consumers.

44. (b)

The non-uniform distribution of electric current over the surface on skin of the conductor carrying a.c in called the skin effect.

45. (b)

In ac transmission system, when we are increasing the inductance of the line, power factor reduces, impedance increases and hence delivered power reduces. So we can say that transmission capacity of the line is inversely proportional to the line.

47. (d)

The relay current (rated) is 5A. If the relay setting is 50%, then the relay can be operated for $5 \times \dfrac{50}{100}$ = 2.5 A. We know that the fault current is 2000 A. Hence the fault current in the secondary of the CT is $5 \times \left(\dfrac{2000}{400}\right)$ = 25 Amps. hence, the plug setting multiplier

$$= \frac{25}{2.5} = 10$$

UPPSC-AE

Combined State Engineering
Services Examination

Section - D

Electrical Engineering

Model Practice Sets

UPPSC-AE

UTTAR PRADESH PUBLIC SERVICE COMMISSION

Combined State Engineering Services Exam : Assistant Engineer

ELECTRICAL ENGINEERING

Model Practice Set : 1

Paper-I

Duration: 2.30 hr. Maximum Marks: 375

Read the following instructions carefully

1. Immediately after the commencement of the examination, you should check that this booklet **does not** have any unprinted or torn or missing pages or items etc. If so, get it replaced by a complete test booklet.
2. Encode clearly the test booklet series **A, B, C** or **D,** as the case may be, in the appropriate place in the answer sheet using ball point pen (blue or black).
3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside.

   DO NOT write **anything else** on the Test Booklet.
4. This Test Booklet contains 125 questions. Each question comprises four responses (answers). All questions carry equal marks. There is provision of negative marking of 1 mark for every wrong answer attempted.
5. Use of calculator is not permitted.
6. Attempt **ALL** questions. Your total marks will depend **Only** on the number of correct responses with corresponding reduction for wrong answers marked by you.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your admission Certificate.
8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to invigilator **Only the Answer Sheet**. You are permitted to take away with you the Test Booklet.

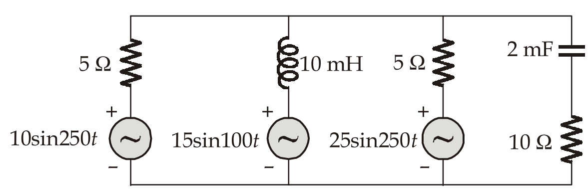
DO NOT OPEN THIS BOOKLET UNTIL YOU ARE ASKED TO DO SO

Q.1 A series resonating circuit has a coil having a resistance of R = 1 kΩ. If the half power frequencies are 10 kHz and 90 kHz, the Q-factor and the resonant frequency of the circuit would be equal to

(a) $\frac{8}{3}$ and 30 kHz (b) $\frac{3}{8}$ and 20 kHz

(c) $\frac{8}{3}$ and 20 kHz (d) $\frac{3}{8}$ and 30 kHz

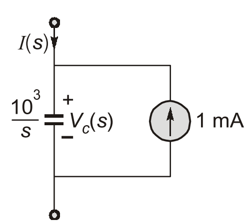
Q.2 In the circuit shown below



Which of the following theorem can be conveniently used to calculate the response in 10 Ω resistance?

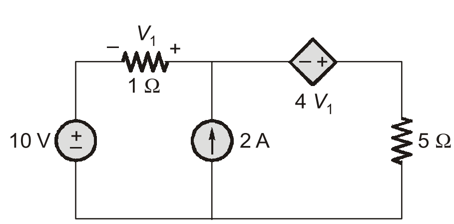
(a) Thevenin's Theorem
(b) Superposition Theorem
(c) Millman's Theorem
(d) Maximum power transfer Theorem

Q.3 A capacitor with some initial voltage can be represented by the shown figure, where s is Laplace transform variable. The value of initial voltage is



(a) 0.5 V (b) 2.0 V
(c) 1.0 V (d) 0 V

Q.4 What is the power loss in the 5 Ω resistor shown below?



(a) 40 W (b) 10 W
(c) 20 W (d) 15 W

Q.5 A practical voltage source is represented by
(a) a resistance in parallel with an ideal voltage source
(b) a resistance in parallel with an ideal current source
(c) a resistance in series with an ideal voltage source
(d) a resistance in series with an ideal current source

Q.6 The theorem that enables a number of voltage (or current) sources to be combined directly into a single voltage (or current) source is the
(a) Reciprocity theorem
(b) Substitution theorem
(c) Compensation theorem
(d) Millman's theorem

Q.7 Which one of the following systems described by the following input-output relations is non-linear?
(a) $y(n) = n\,x(2n)$ (b) $y(n) = x(n^2)$
(c) $y(n) = n^2 x(n)$ (d) $y(n) = x^2(n)$

Q.8 If $f(t)$ is an even function, then what is its Fourier transform $F(j\omega)$?

(a) $\int_0^{\infty} f(t)\cos(2\omega t)dt$

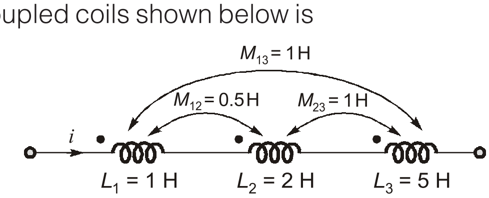
(b) $2\int_0^{\infty} f(t)\cos(\omega t)dt$

(c) $2\int_0^{\infty} f(t)\sin(\omega t)dt$

(d) $2\int_0^{\infty} f(t)\sin(2\omega t)dt$

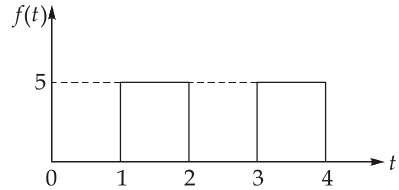
Q.9 Consider a system with transfer function $H(s) = \frac{3s^2 - 2}{s^2 + 3s + 2}$. The step response of the system is given by
(a) $c(t) = 5e^{-2t} - e^{-t} - 1$
(b) $c(t) = 3\delta(t) - 10e^{-2t} + e^{-t}$
(c) $c(t) = 4e^{-t} - e^{-2t} - 1$
(d) $c(t) = 2(1 - e^{-2t})$

Q.10 The total inductance of the three series connected coupled coils shown below is



(a) 19 H (b) 23 H
(c) 13 H (d) 11 H

Q.11 The Laplace transform of the waveform shown below is



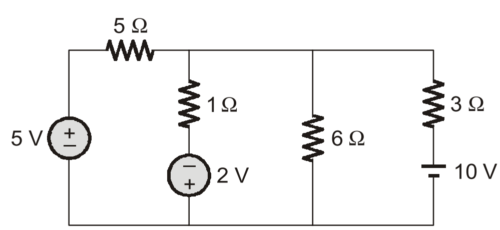
(a) $\frac{5}{s}(e^{-s}+e^{-2s}-e^{-3s}-e^{-4s})$

(b) $\frac{5}{s}(-e^{-s}+e^{-2s}-e^{-3s}+e^{-4s})$

(c) $\frac{5}{s}(e^{-s}-e^{-2s}-e^{-3s}+e^{-4s})$

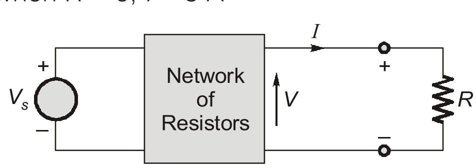
(d) $\frac{5}{s}(e^{-s}-e^{-2s}+e^{-3s}-e^{-4s})$

Q.12 The current flowing through the 6 Ω resistor shown below is



(a) 18.66 mA (b) 22.88 mA
(c) 14.44 mA (d) 32.22 mA

Q.13 A two port network has been shown in figure where the block represents a network of resistors. A resistance *R* is connected at the output. The given conditions of the network are
(i) when $R = \infty$, $V = 10$ volt
(ii) when R = 0, $I = 5$ A



What is the value of *V* when $R = 8\ \Omega$?
(a) 8 V (b) 2 V
(c) 4 V (d) 6 V

Q.14 A system is described by the transfer function $H(s) = \frac{1}{s+a}$. The value of its step response at a very large time will be closed to

(a) $\frac{1}{a}$ (b) a

(c) (1 – a) (d) zero

Q.15 If the length of a wire of resistance *R* is uniformly stretched to *n* times its original value, its new resistance is

(a) nR (b) $\frac{R}{n}$

(c) n^2R (d) $\frac{R}{n^2}$

Q.16 The current in a coil of self inductance 2.0 henry is increasing according to $i = 2\sin t^2$ amp. The amount of energy spent during the period when the current changes from 0 to 2 A is
(a) 1 Joule (b) zero
(c) 1.5 Joule (d) 4 Joule

Q.17 A charge of 10 pC is at rest in free space. The potential at a point, 10 cm away from the charge is equal to
(a) 1.0 V (b) 0.9 V
(c) 0.6 V (d) 1.1 V

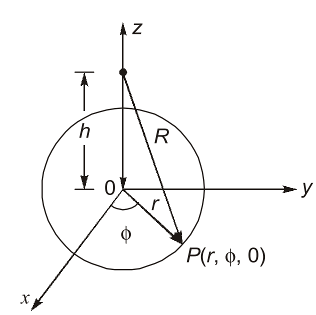
Q.18 The capacitance of an isolated sphere of radius 1 cm is
(a) 0.55 pF (b) 2.22 pF
(c) 3.33 pF (d) 1.11 pF

Q.19 Which of the following is an example of non-polar dielectrics?
(a) HCl (b) CH_4
(c) CO_2 (d) NH_3

Q.20 The unit of electric polarization is
(a) Coulomb/m (b) Coulomb-m
(c) Coulomb/m^2 (d) Coulomb/m^3

Q.21 Which of the following is a source of magnetostatic fields?
(a) a permanent magnet
(b) a stationary charge
(c) an electric field linearly changing with time
(d) Both (a) and (c)

Q.22 The unit vector $\vec{a}_R$ which points from $z = h$ on the *z*-axis towards $(r, \phi, 0)$ in cylindrical coordinates as shown below is given by



UPPSC-AE

Model Practice Set : 1

Electrical Engineering

Answer Key

Paper-I

1.	(d)	26.	(d)	51.	(d)	76.	(c)	101.	(d)
2.	(b)	27.	(a)	52.	(c)	77.	(b)	102.	(b)
3.	(c)	28.	(c)	53.	(c)	78.	(c)	103.	(d)
4.	(c)	29.	(d)	54.	(d)	79.	(d)	104.	(c)
5.	(c)	30.	(d)	55.	(b)	80.	(b)	105.	(b)
6.	(d)	31.	(c)	56.	(b)	81.	(d)	106.	(d)
7.	(d)	32.	(b)	57.	(c)	82.	(d)	107.	(c)
8.	(b)	33.	(b)	58.	(b)	83.	(d)	108.	(d)
9.	(a)	34.	(a)	59.	(d)	84.	(d)	109.	(d)
10.	(c)	35.	(c)	60.	(c)	85.	(b)	110.	(c)
11.	(d)	36.	(a)	61.	(b)	86.	(a)	111.	(a)
12.	(b)	37.	(b)	62.	(d)	87.	(b)	112.	(b)
13.	(a)	38.	(a)	63.	(b)	88.	(d)	113.	(c)
14.	(a)	39.	(b)	64.	(b)	89.	(c)	114.	(b)
15.	(c)	40.	(b)	65.	(c)	90.	(b)	115.	(a)
16.	(d)	41.	(d)	66.	(b)	91.	(c)	116.	(d)
17.	(b)	42.	(b)	67.	(c)	92.	(b)	117.	(b)
18.	(d)	43.	(c)	68.	(c)	93.	(b)	118.	(a)
19.	(b)	44.	(b)	69.	(b)	94.	(d)	119.	(c)
20.	(c)	45.	(b)	70.	(d)	95.	(c)	120.	(a)
21.	(d)	46.	(b)	71.	(b)	96.	(b)	121.	(c)
22.	(b)	47.	(c)	72.	(c)	97.	(b)	122.	(b)
23.	(c)	48.	(c)	73.	(b)	98.	(c)	123.	(a)
24.	(a)	49.	(c)	74.	(b)	99.	(d)	124.	(d)
25.	(d)	50.	(b)	75.	(d)	100.	(a)	125.	(b)

DETAILED EXPLANATIONS

1. (d)

Bandwidth, $BW = f_2 - f_1 = 90 - 10 = 80$ kHz

In series circuit,

$$f_0 = \sqrt{f_1 f_2} = \sqrt{10 \times 90} \text{ kHz} = 30 \text{ kHz}$$

The Q-factor of the coil is

$$Q = \frac{f_0}{BW} = \frac{30}{80} = \frac{3}{8}$$

Hence, Q-factor = $\frac{3}{8}$ and Resonant frequency = 30 kHz.

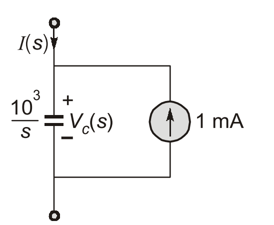
2. (b)

$\because$ The reactive elements are frequency sensitive

i.e. $Z_L = j\omega L \Omega$ and $Z_C = \frac{1}{j\omega C}\Omega$. Therefore superposition theorem is used as the two different frequencies are simultaneously operating on the network.

3. (c)

A charged capacitor can be represented as a current source, while applying KCL at node, we can write,

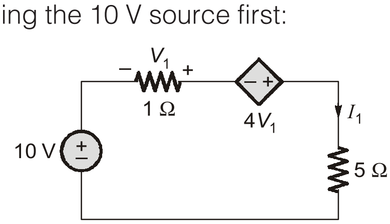


$$I(s) = CsV_C(s) - CV_C(0^-)$$
$$CV_C(0^-) = 1 \text{ mA}$$
$$C = 10^{-3} F \left(\because \frac{1}{sC} = \frac{10^3}{s}\right)$$
$$\therefore \quad V_C(0^-) = \frac{1\text{mA}}{1\text{mF}} = 1\text{V}$$

4. (c)

Let us apply Superposition theorem

Assuming the 10 V source first:



Applying KVL, we have:

$-10 - v_1 - 4v_1 + 5I_1 = 0$

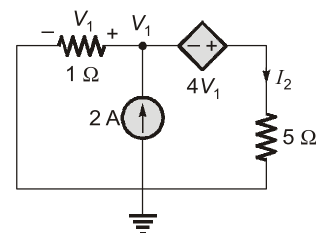
or, $\quad 5I_1 = 5v_1 + 10 \quad$ ...(i)

Also, $\quad v_1 = -1 \times I_1 \quad$ ...(ii)

From equations (i) and (ii), we have

$$5I_1 = -5I_1 + 10 \quad \text{or} \quad I_1 = 1 \text{ A}$$

Assuming the 2 A current source:



Applying KCL at node,

$$2 = \frac{v_1}{1} + \frac{v_1 + 4v_1}{5}$$
$$= v_1 + 0.2v_1 + 0.8v_1$$

or, $\quad v_1 = 1$ V

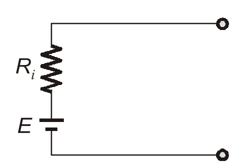
$$\therefore \quad I_2 = \frac{v_1 + 4v_1}{5} = \frac{5v_1}{5} = 1 \text{ A}$$

Hence, current through 5 Ω resistor is

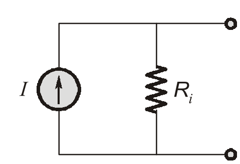
$$I = I_1 + I_2 = 2 \text{ A}$$

$\therefore$ Power loss in 5 Ω resistor = $(2)^2 \times 5 = 20$ W

5. (c)



An ideal voltage source



An ideal curent source

6. (d)

Millman's theorem enables a number of voltage (or current) sources to be combined into a single voltage (or current) source. This theorem is a combination of Thevenin's and Norton's theorem.

7. (d)

$$y(n) = x^2(n)$$

If the output $y(n)$ of the system is dependent on the $x(n)$ input having degree other than 1 are most likely to be non linear.

Looking at the option only option (d) satisfies it.

8. (b)

$$F(j\omega) = \int_{-\infty}^{\infty} f(t)\, e^{-j\omega t} dt$$

$$= \int_{-\infty}^{\infty} f(t)\, \{\cos \omega t - j \sin \omega t\}\, dt$$

$\because$ even function × even function = even function

& even function × odd function = odd function

$$F(j\omega) = \int_{-\infty}^{\infty} f(t) \cos \omega t\, dt$$

$$= 2\int_{0}^{\infty} f(t) \cos \omega t\, dt$$

9. (a)

$$H(s) = \frac{3s^2 - 2}{s^2 + 3s + 2} = \frac{C(s)}{R(s)}$$

Since the input signal is step so $R(s) = \frac{1}{s}$

So, $$C(s) = \frac{(3s^2 - 2)}{s(s+1)(s+2)}$$

$$= \frac{-1}{s} - \frac{1}{(s+1)} + \frac{5}{(s+2)}$$

Taking its inverse Laplace transform

$$c(t) = -1 - e^{-t} + 5e^{-2t}$$

10. (c)

Using the given dot polarities, we observe that:

Net inductance for coil-1 is

$$L' = L_1 + M_{12} + M_{13} = 1 + 0.5 + 1 = 2.5 \text{ H}$$

Net inductance for coil - 2 is:

$$L'' = L_2 + M_{23} + M_{12} = 2 + 1 + 0.5 = 3.5 \text{ H}$$

Net inductance for coil - 3 is:

$$L''' = L_3 + M_{13} + M_{23} = 5 + 1 + 1 = 7 \text{ H}$$

$\therefore$ The total inductance is

$$L = L' + L'' + L''' = 2.5 + 3.5 + 7 = 13 \text{ H}$$

11. (d)

The given waveform can be representated as

$$f(t) = f_1(t) + f_2(t)$$

Here, $f_1(t) = 5\,[u(t-1) - u(t-2)]$

and $f_2(t) = 5\,[u(t-3) - u(t-4)]$

Thus,

$$f(t) = 5[u(t-1) - u(t-2)] + 5[u(t-3) - u(t-4)]$$

Taking Laplace transform on both sides, we have

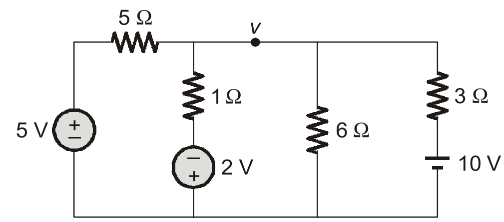
$$F(s) = 5\left[\frac{1}{s}e^{-s} - \frac{1}{s}e^{-2s}\right] + 5\left[\frac{1}{s}e^{-3s} - \frac{1}{s}e^{-4s}\right]$$

or, $$F(s) = \frac{5}{s}(e^{-s} - e^{-2s} + e^{-3s} - e^{-4s})$$

12. (b)

Let the node voltage be 'V' volts.

Applying KCL at this node, we have



$$\frac{V-5}{5} + \frac{V+2}{1} + \frac{V}{6} + \frac{V-10}{3} = 0$$

or, $$\frac{6\,V - 30 + 30\,V + 60 + 5\,V + 10\,V - 100}{30} = 0$$

or, $51\,V - 70 = 0$

or, $$V = \frac{70}{51} \text{ volt}$$

$\therefore$ Current through the 6 Ω resistor

$$= \frac{V}{6} = \frac{70}{6 \times 51} \approx 22.88 \text{ mA}$$

13. (a)

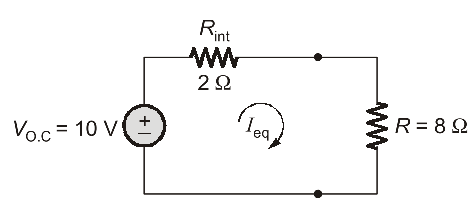
When $R = \infty$, $V = 10$ volt i.e., $V_{oc} = 10$ V

when $R = 0$, I = 5 A i.e., $I_{sc} = 5$ V

$\therefore$ R_{int} (equivalent R of the block)

$$= \frac{V_{oc}}{I_{sc}} = \frac{10}{5} = 2\ \Omega$$

The equivalent network is shown below:



Here, $$I_{eq} = \frac{V_{OC}}{R_{int} + R} = \frac{10}{2+8} = 1 \text{ A}$$

Hence, $V = I_{eq} \times R = 1 \times 8 = 8$ V

14. (a)

Given $$H(s) = \frac{C(s)}{R(s)} = \frac{1}{s+a}$$

Also, input = unit step function

$\therefore$ $$R(s) = \frac{1}{s}$$

Hence, $$C(s) = \frac{1}{s(s+a)} = \frac{A}{s} + \frac{B}{s+a}$$