

CBCS SCHEME

BEC401

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Fourth Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026 Electromagnetic Theory

Time: 3 hrs.

Max. Marks: 100

*Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.*

Module - 1			M	L	C
Q.1	a.	Point charges of 50 nC each are located at A (1 , 0 , 0), B. (-1,0,0) , C (0,1,0) and D (0, -1, 0) in free space. Find the total force on the charge located at A .	08	L3	CO1
	b.	Obtain an expression for electric field intensity at a distant point due to infinite long line charge.	08	L2	CO1
	c.	Define Electric flux density.	04	L2	CO1
OR					
Q.2	a.	Find the total charge within the volume $0 \leq \rho \leq 0.1, 0 \leq \phi \leq \pi, 0 \leq z \leq 4$ If $\rho_v = \rho^2 z^2 \sin(0.6\phi)$	08	L3	CO1
	b.	Given a 60 μ C point charge located at the origin, find the total electric flux passing through i) that portion of the sphere $r = 26$ cm bounded by $0 \leq \theta \leq \pi/2$ and $0 \leq \phi \leq \pi/2$ ii) The closed surface defined by $\rho = 26$ cm and $z = \pm 26$ cm.	08	L3	CO1
	c.	Define surface charge and volume charge density.	04	L1	CO1
Module - 2					
Q.3	a.	State and prove Divergence theorem.	06	L2	CO2
	b.	Calculate volume charge density ρ_v if $\vec{D} = \frac{10 \cos \theta \sin \phi}{r} \vec{a}_r$ c/m ²	08	L3	CO2
	c.	Derive point form of continuity equation.	06	L2	CO2
OR					
Q.4	a.	State and prove Gauss Law.	05	L2	CO2
	b.	Given the electric field $\vec{E} = 2x\vec{a}_x - 4y\vec{a}_y$ v/m Find the work done in moving a point charge 2c from (2, 0,0) to (0, 0, 0) and then from (0, 0,0) to (0, 2, 0).	07	L3	CO3
	c.	If $\vec{D} = \frac{5r^2}{4} \vec{a}_r$ c/m ² , then evaluate both sides of the divergence theorem for the volume enclosed by $r = 4$ m, $\theta = \pi/4$ radians	08	L3	CO3
Module - 3					
Q.5	a.	Starting from point form of Gauss law deduce Poisson's and Laplace's equation.	06	L2	CO3
	b.	Using Laplace's equation obtain an expression for capacitance of parallel plate capacitor.	08	L3	CO3
	c.	State and explain Ampere's Law.	06	L1	CO3

OR

Q.6	a.	Derive an expression for magnetic field intensity at a distant point due to infinite long straight conductor using Biot – Savart's law.	08	L2	CO3
	b.	State and explain Stoke's theorem.	06	L1	CO3
	c.	Given $\vec{H} = [y \cos(\alpha x)]\vec{a}_x + (y + e^x)\vec{a}_z$ A/M. Find current density vector over yz plane.	06	L3	CO3

Module – 4

Q.7	a.	Derive the expression for force between the differential current elements.	08	L2	CO4
	b.	Obtain Lorentz force equation.	06	L2	CO4
	c.	A conductor 4 m long lies along the y – axis with a current of 10 A in the \vec{a}_y direction. Find the force on the conductor if the field is $\vec{B} = 0.005 \vec{a}_x$ Tesla.	06	L3	CO4

OR

Q.8	a.	Define Magnetization and Permeability.	04	L1	CO4
	b.	If $\vec{B} = 0.05 \times \vec{a}_y$ T in a material for which magnetic susceptibility $X_m = 2.5$. Find: i) μ_r ii) μ iii) \vec{H} iv) \vec{M} v) \vec{J}	08	L3	CO4
	c.	Discuss the boundary conditions at the interface between two media of different permeabilities.	08	L4	CO4

Module – 5

Q.9	a.	Write Maxwell's equations in point form and integral form for time varying fields.	08	L2	CO5
	b.	Find the frequency at which conduction current density and displacement current density are equal in a medium with $\sigma = 2 \times 10^4$ Ω^{-1}/m and $\epsilon_r = 81$	06	L3	CO5
	c.	Do the fields $\vec{E} = E_m \sin x \sin t \vec{a}_y$ and $\vec{H} = \frac{E_m}{\mu_0} \cos x \cos t \vec{a}_z$ satisfy Maxwell's equation?	06	L3	CO5

OR

Q.10	a.	Derive a wave equation for a uniform plane wave in free space.	08	L2	CO5
	b.	State and prove poynting theorem.	08	L2	CO5
	c.	The depth of penetration in a certain conducting medium is 0.1 m and frequency of the electromagnetic wave is 1.0 MHz. Find the conductivity of the medium.	04	L3	CO5

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Fourth Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026
Control System

Max. Marks: 100

Time: 3 hrs.

*Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
 2. M : Marks , L: Bloom's level , C: Course outcomes.*

Module - 1			M	L	C
Q.1	a.	Define Control System. Compare open loop and closed loop system.	05	L1	CO1
	b.	Explain closed loop control system with an example.	05	L1	CO1
	c.	For mechanical system shown in Fig. Q.1 (c). i) Draw mechanical network ii) Write differential equations iii) Draw electrical network by F - V analogy.	10	L2	CO1
Fig. Q.1 (c)					
OR					
Q.2	a.	For the mechanical system shown in Fig. Q 2 (a). i) Draw mechanical network ii) Draw the analogous electrical circuit in which force is analogous to current.	10	L2	CO1
Fig. Q 2 (a)					
1 of 4					

b. For the mechanical system shown in Fig. Q 2(b):
 i) Draw the mechanical network
 ii) Draw the electrical network based on torque – current analogy and write performance equations for mechanical system.

10 L2 CO1

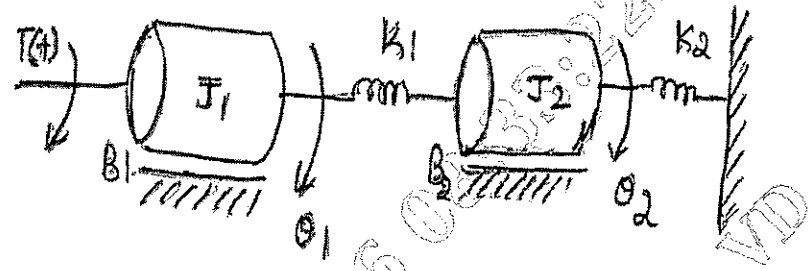


Fig. Q. 2 (b)

Module – 2

Q.3 a. Solve using the Mason gain formula for the given signal flow graph shown in Fig. Q. 3 (a).

10 L2 CO1

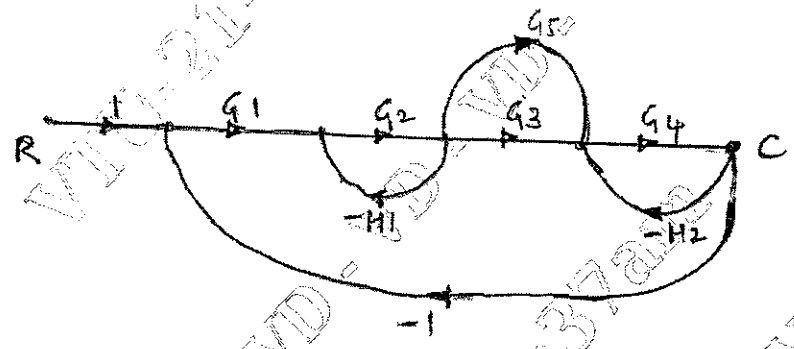


Fig. Q. 3 (a)

b. The system block diagram is shown in Fig. Q 3 (b). Find $C(s)/R(s)$.

10 L2 CO1

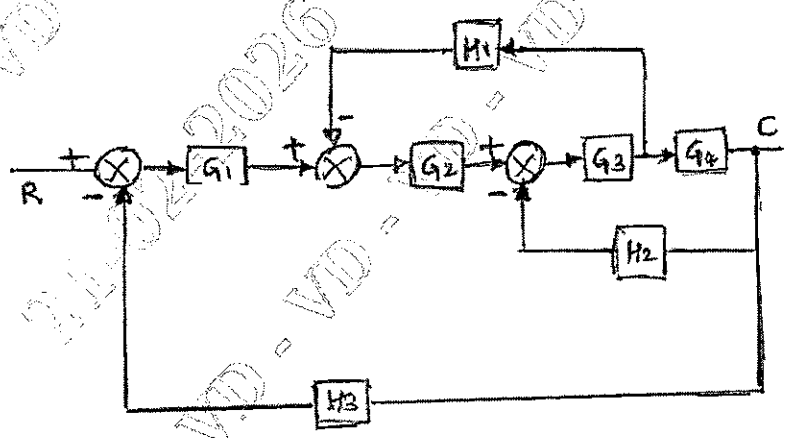


Fig. Q 3 (b)

OR

Q.4 a. Find $C(s) / R(s)$ by using Mason's gain formula shown in Fig. Q4 (a). 10 L2 CO1

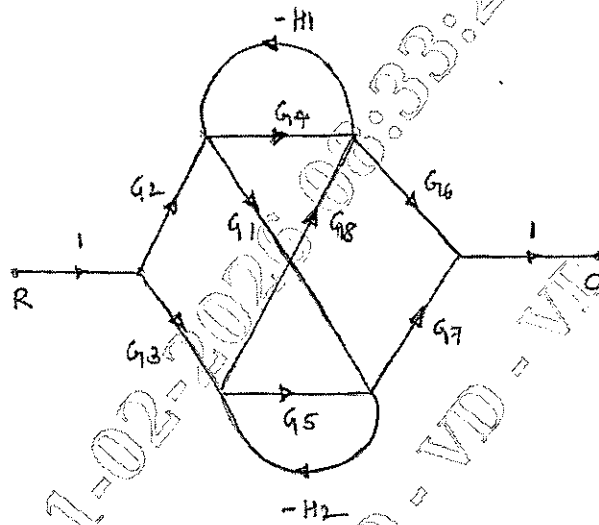


Fig. Q. 4(a)

b. Write the six rules of reducing block diagram. 06 L1 CO1
 c. Define Mason's gain formula in signal flow graph. 04 L1 CO1

Module - 3

Q.5 a. Starting from the output equation $c(t)$ derive expressions for :
 i) Peak time (t_p)
 ii) Peak overshoot (m_p) of an under damped second order system subjected to unit step input. 10 L2 CO2
 b. A unity feedback system is characterized by open loop transfer function $G(s) = \frac{K}{s(s+10)}$. Determine the value of K so that the system will have the damping ratio of 0.5 of this value of K. Determine the settling time. Peak overshoot and rise time for a unit step input. 10 L3 CO2

OR

Q.6 a. Derive an expression for $C(t)$ of an underdamped second order system for unit step input. 08 L2 CO2
 b. Explain the following test signals with the help of graph and mathematical expression.
 i) step signal ii) Ramp Signal iii) Parabolic signal 06 L1 CO2
 c. What are static error coefficients? Derive the formula for each. How they are related to the steady state error. 06 L2 CO2

Module - 4

Q.7 a. The characteristic equation of a feedback control system is $S^3 + 3KS^2 + (K+2)S + 4 = 0$. Determine the range of K for which the system is stable. 10 L3 CO3
 b. Draw root locus diagram for a system having $G(s).H(s) = \frac{K}{s(s+1)(s+3)}$ 10 L3 CO3

OR

Q.8	a.	Explain the construction rules of root locus.	10	L2	CO3
	b.	The open loop transfer function of unity feedback system is given by $G(s) = \frac{K}{s(s+3)(s^2+s+1)}$ Determine the values of K that will cause sustained oscillations in the closed loop system. Also find the oscillation frequency.	10	L3	CO3
Module - 5					
Q.9	a.	Construct the Bode plot for a unity feedback system whose open loop transfer function is given by $G(s) = \frac{80}{s(s+2)(s+20)}$ From the Bode plot determine, i) Gain Margin iii) Gain cross over frequency ii) Phase Margin iv) Phase cross over frequency	10	L3	CO4
	b.	For a control system $G(s):H(s) = \frac{K}{s(s+2)(s+10)}$ Sketch the Nyquist plot and hence calculate range of K for stability.	10	L3	CO4
OR					
Q.10	a.	Construct Bode plot for a unity feedback system with $G(s) = \frac{10(s+10)}{s(s+2)(s+5)}$ From the Bode plot find i) Gain Margin ii) Phase Margin Also comment on stability.	10	L3	CO4
	b.	Explain the terms: i) State iii) State vector ii) State variable iv) State space	04	L1	CO5
	c.	Find the state transition matrix for $A = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$	06	L3	CO5
