	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electrical and Electronics Engineering**	Year of Regulation	**2019-20**
Department	**Electrical Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EE302	**Control Systems**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

After the completion of the course, the student should be able to:

Course Objectives	Course Outcomes		
To introduce the basic concepts, elements and terminologies of control systems.		CO1	**acquire knowledge about the control systems, its applications.**
To model and discuss different physical systems (plants) in Laplace and state-space frameworks.		CO2	**obtain the mathematical models of dynamic systems in transfer function and state-space forms.**
To study the performance and stability of LTI systems in time and frequency domains.		CO3	**Analyse and define the LTI system performance and stability in both time-domain and frequency domain.**
To discuss and design compensators/ controllers using analytical and graphical techniques.		CO4	**compute the Root locus and design the appropriate compensator using Root locus technique.**
		CO5	**compute Bode, Nyquist plots and design the appropriate compensator using Bode plot technique.**
		CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**2**	**1**	**0**	**2**	**2**	**2**	**0**	**0**	**2**	**0**	**2**	**1**	**1**	**1**
2	CO2	**1**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**0**	**1**	**0**	**2**	**3**	**2**	**2**
3	CO3	**2**	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**2**	**3**	**2**	**3**
4	CO4	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**2**	**3**	**3**
5	CO5	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**3**
6	CO6															

SYLLABUS

No.	Content	Hours	COs
I	**Basic Concepts** Basic definition, basic elements of control system, open loop control system, closed loop control system, control system terminology, manually controlled closed loop systems, automatic controlled closed loop systems, basic elements of a servo mechanism, electrical analogue of multidisciplinary systems, Notion of Feedback.	**05**	**CO1**

II	**Modelling and Representations of Control Systems** Ordinary Differential Equations, derivation of transfer functions of physical systems, block diagram representation of physical systems, signal flow graphs, conversion of block diagram to signal flow graph, block diagram reduction technique, signal flow graph Manipulation using Mason's gain formula. State-Space Representation of physical systems.	**07**	**CO2**
III	**Linear System Performance in Time and Frequency Domain** Standard test signals, significance of system impulse response, Transient step response analysis of zero, first and second order systems and determination of different time domain performance specification, steady state error analysis for Type-0, Type-1 and Type-2 systems, static and dynamic errors coefficients, and errors criteria, significance of system sinusoidal response, Frequency response analysis of first and second order system, link between time and frequency domain response, Effect of addition of poles and zeros on system time response.	**07**	**CO1** **CO3**
IV	**Stability of LTI Systems** Fundamental concepts of LTI system stability, Definitions of stability: BIBO stability, Absolute stability, relative stability, limited stability, asymptotic stability etc., Determination of closed loop control system stability from characteristic equation: Routh stability criterion, Hurwitz stability criterion.	**05**	**CO1** **CO3**
V	**Graphical Techniques for Measurement of System Relative Stability** The Root-Locus concepts, Construction of Root Loci, Root contour, Frequency domain techniques: Bode-plot, Polar-plot, Nyquist plot, Nyquist Stability Criterion for open loop stable and unstable systems, concept of Gain Margin, Phase Margin, Closed loop frequency response.	**06**	**CO4** **CO5**
VI	**Compensator Design** Introduction, different types of compensators, design of lag, lead, lag-lead compensators using root locus and Bode diagrams, design of P, PI, PD and PID controllers by analytical method, frequency response method and root locus technique.	**06**	**CO4** **CO5**
Total Hours		**36**	

Essential Readings

1. K. Ogata, "Modern Control Engineering", Prentice Hall, 5th Edition, 2010.
2. I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International, 6th Edition, 2018.

Supplementary Readings

1. N. S. Nise, "Control System Engineering", Wiley India, 7th Edition, 2015.
2. R. C. Dorf, R. H. Bishop, "Modern Control Systems", Pearson, 13th Edition, 2017.
3. B. C. Kuo, "Automatic Control Systems", Wiley India, 9th Edition, 2014.