	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electrical and Electronics Engineering**	Year of Regulation	**2018-19**
Department	**Electrical Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EE417	**Advanced Control Systems**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

		After the completion of the course, students should be:		
Course Objectives	**To introduce the continuous time linear and nonlinear systems in state space framework.**	Course Outcomes	CO1	**able to acquire knowledge about continuous time systems and nonlinear systems in state space and their applications.**
	To model and discuss performance, stability of different continuous time dynamic systems in the state-space framework.		CO2	**able to obtain the mathematical models of linear and nonlinear control systems in the state-space form.**
	To design of different controllers and observers using analytical and graphical techniques.		CO3	**able to analyse the performance and stability of continuous time dynamic systems.**
			CO4	**able to apply linear and nonlinear analysis techniques.**
			CO5	**able to design different types of controller and observer for linear and nonlinear systems.**
			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**	**2**	**2**	**1**	**2**	**1**	**0**	**1**	**2**	**2**	**3**	**2**	**1**	**1**
2	CO2	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**0**	**1**	**2**	**1**	**2**	**2**	**2**	**3**
3	CO3	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**0**	**2**	**1**	**3**	**2**	**2**	**2**
4	CO4	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**1**	**2**	**3**
5	CO5	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**3**	**2**	**2**	**3**

SYLLABUS

No.	Content	Hours	COs
I	**Continuous time Systems in State-Space** Introduction of State-Space, modelling of dynamic systems, State Diagram, Linear Transformation of state variables, State-Space representation in Canonical forms: Controllable, Observable and Jordan Diagonal canonical forms. Conversions between State Space and Transfer Functions model. State transition matrix (STM), Properties of State Transition Matrix, Computation of State Transition Matrix by Laplace transform approach, Solution of Homogeneous and Non-homogeneous state equations of continuous time invariant systems. Concepts of Controllability, Observability, Stabilizability and Detectability.	**11**	**CO1** **CO2** **CO3**
II	**State Feedback Control and Observer Design** Design of state variable feedback, Regulator design via pole placement method, Determination of full state feedback gain using Direct-comparison method, Controllable canonical form method and Ackermann's formula. Principle of duality, State observers, Design of Full order state observers, Reduced order state observers. Separation principle, Design of observed state feedback control.	**06**	**CO1** **CO2** **CO5**
III	**Nonlinear Control System Analysis** Introduction, Common physical nonlinearities. The Phase-Plane analysis: singular points, Phase portrait, Limit Cycle, Qualitative behaviour near equilibrium points, Jacobian linearization of second order systems and nonlinear systems, Construction of phase trajectories-Analytical method, Isocline method, Delta method, Stability of nonlinear system by Phase-Plane method. The Describing function analysis, Harmonic Linearization, Derivation of Describing function of typical nonlinearities, existence of limit cycles, Stability analysis by describing function method, Jump resonance: Frequency-amplitude dependence and multivalued response.	**10**	**CO1** **CO2** **CO3** **CO4**
IV	**Lyapunov's Stability Analysis and Control Design** Stability definitions-local stability, asymptotic stability, asymptotic stability in large, Instability, Lyapunov's stability criterion, Lyapunov function, Sign definiteness of scalar functions, Sylvester's criterion, Lyapunov's Direct method for linear systems, Construction of Lyapunov function, Asymptotic stability of nonlinear systems with feedback. Nonlinear control design using Lyapunov approach.	**09**	**CO1** **CO2** **CO4** **CO5**
	Total Hours	**36**	

Essential Readings

1. K. Ogata, "Modern Control Engineering", Pearson Education India, 5th Edition, 2015.
2. I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International, 6th Edition, 2017.
3. H. J. Marquez, "Nonlinear Control Systems: Analysis and Design", John Wiley Interscience, 2nd Edition, 2003.
4. J. E. Slotine and W. Li, "Applied nonlinear control", Prentice Hall, 1st Edition, 1991.

Supplementary Readings

1. N. S. Nise, "Control System Engineering", Wiley India, 5th Edition, 2009.
2. F. Golnaraghi, B. C. Kuo, "Automatic Control Systems", Wiley India, 9th Edition, 2014.
3. H. K. Khalil., "Nonlinear Systems", Prentice Hall, 3rd Edition, 2014.