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

Programme	**Master of Technology in Power and Energy Systems**	Year of Regulation	**2018**
Department	**Electrical Engineering**	Semester	**II**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EE510	**Advanced Control Systems**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

		After the completion of the course, students should be able to:		
Course Objectives	**To introduce the continuous time linear and nonlinear systems, digital systems in state space framework.**	Course Outcomes	CO1	**acquire knowledge about continuous time systems, digital systems, nonlinear systems in state space and their applications.**
	To model and discuss different dynamic systems in the state-space framework.		CO2	**obtain the mathematical models of linear, nonlinear and digital control systems in the state-space form.**
	To study the performance and stability of continuous and discrete time dynamic systems.		CO3	**analyse the performance and stability of continuous and discrete time dynamic systems.**
	To discuss the design of different controllers and observers using analytical and graphical techniques.		CO4	**apply linear and nonlinear analysis techniques**
			CO5	**design different types of controllers 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**
6	CO6															

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to State-Space** Introduction of State-Space, State-Space representation in Canonical forms: Diagonal, Controllable, Observable, & Jordan Diagonal canonical form. Conversions between State Space and Transfer Functions model. State transition matrix, solution of Homogeneous and Non-homogeneous State equation of continuous time invariant systems. Concepts of Controllability, Observability, Stabilizability & Detectability. 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.	**06**	**CO1** **CO2** **CO3** **CO5**
II	**Discrete Time Control System Design** Issues involved in the method of sampling in practical control systems, frequency folding, bilinear transformation and stability analysis of sample data systems, frequency domain design of digital control system, study of digital optimal dead-beat control, digital PID controllers, DDC approach of control systems, position and incremental PID algorithms.	**05**	**CO1** **CO2** **CO5**
III	**State Estimator Based Control Design** Issues of state feedback design, concept of state estimators, full order and reduced order design of state estimator, compensator design by separation principle, a case study of state estimator-based position servo mechanism.	**05**	**CO1** **CO2** **CO5**
IV	**Lyapunov Stability Analysis** Nonlinear systems and equilibrium points, concepts of stability, linearization and local stability, Lyapunov's direct method, system analysis based on Lyapunov's direct method, control design based on Lyapunov's direct method.	**10**	**CO2** **CO3** **CO4**
V	**Sliding Mode Control** Sliding surfaces, Filippov's construction of the equivalent dynamics, direct implementations of switching control laws, continuous approximations of switching control laws, modeling/performance trade-offs.	**05**	**CO1** **CO5**
VI	**Adaptive Control** Basic concepts in adaptive control, adaptive control of first-order systems, adaptive control of linear systems, adaptive control of nonlinear systems, robustness of adaptive control systems, on-line parameter estimation.	**05**	**CO1** **CO5**
	Total Hours	**36**	

Essential Readings

1. M. Gopal, "Digital Control and State Variable Methods", TMH, 3rd Edition, 2008.
2. H. J. Marquez, "Nonlinear Control Systems: Analysis and Design", John Wiley Interscience, 2nd Edition, 2003.
3. J. E. Slotine and W. Li, "Applied nonlinear control", Prentice Hall, 1st Edition, 1991.

Supplementary Readings
1. K. Ogata, “Modern Control Engineering”, PHI, 5th Edition, 2010.
2. K. Ogata, “Discrete time Control Systems”, Pearson Education India, 2nd Edition, 2015.
3. H. K. Khalil., “Nonlinear Systems”, Pearson Education India, 3rd Edition, 2014.