	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**PhD Electronics and Communication Engineering**	Year of Regulation	**2021-22**
Department	**Electronics and Communication Engineering**	Semester	**II**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 546	**Machine Learning for Communications and Signal Processing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	To introduce linear models for regression and classification	Course Outcomes	CO1: Able to understand linear models for regression and classification
	To familiarize students with the terminology of neural networks and its types		CO2: Able to acquire knowledge about neural networks, types of machine learning
	To explore the concepts of kernel methods, mixture models and its use in machine learning		CO3: Able to gain insights into kernel methods
	To summarize the application of machine learning in wireless communication		CO4: Able to analyse mixture models, EM algorithm, latent variables, reinforcement learning

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	PSO4
1	CO1	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**2**	**3**	**0**
2	CO2	**3**	**2**	**2**	**2**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**3**	**1**	**2**	**0**
3	CO3	**2**	**2**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**	**3**	**0**
4	CO4	**1**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**3**	**2**	**0**

SYLLABUS

No.	Content	Hours	COs
I	**Probability Distributions:** Binary variable, multinomial variables, The Gaussan Distribution, The exponential family, Nonparametric methods	02	CO1
II	**Linear models for regression and classification:** Maximum likelihood and least squares, The bias-variance decomposition, Bayesisn linear regression, The Evidence Approximation, MIMO zero forcing receiver design, MIMO MMSE receiver design, Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models, The Laplace Approximation, Bayesian Logistic Regression	07	CO1
III	**Neural Networks:** Feed-forward Network Functions, Network Training, Error Backpropagation, The Hessian Matrix, Regularization in Neural Networks, Bayesian Neural Networks	06	CO2
IV	**Kernel Methods:** Constructing Kernels, Gaussian processes for regression, Learning the hyperparameters, Gaussian processes for classification, Laplace approximation, Sparse Kernel Machines - Support vector machines (SVM), Sparse Bayesian learning (SBL)	05	CO2 CO3
V	**Mixture Models, EM algorithm and continuous latent variables:** K-means Clustering, Mixtures of Gaussians, EM for Gaussian mixtures, The EM Algorithm in General, Principal Component Analysis, Autoencoders	07	CO2 CO4
VI	**Reinforcement learning:** Markov decision process, Model-based methods, Model-free methods, Deep reinforcement learning	03	CO2 CO4
VII	**Applications:** Machine learning for detection in digital communication systems, GMM for massive MIMO clustering, SVM for beamforming, ML based adaptive modulation classification, ML based channel estimation, Machine Learning for Joint Channel Equalization and Signal Detection	06	CO2 CO3 CO4
	Total Hours	36	

Essential Readings

1. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, First edition, Springer, 2006.
2. Ruisi He, Z Ding, “Applications of Machine Learning in Wireless Communications”, First edition, IET Telecommunication series 81, 2019.
3. Fa-Long Luo," Machine Learning for Future Wireless Communications", First edition, John Wiley and Sons, 2020.
4. S. Haykin, “Neural networks and Learning Machines”, Third Edition, Pearson Education, 2013.

Supplementary Readings

1. Murphy, Kevin P, “Machine learning: a probabilistic perspective”, First edition, MIT press, 2012.
2. Richard O. Duda, Peter E. Hart and David G. Stork, “Pattern Classification”, Second edition, John Wiley, 2001.