	National Institute of Technology Meghalaya An Institute of National Importance		**CURRICULUM**
Programme	**M.Tech/Ph.D**	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 544	**Array Signal Processing**		**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Introducing of fundamentals of sensor arrays and array signals	Course Outcomes	CO1	Able to explain the fundamentals of arrays, signal models to use in various domains.
	Introducing of concepts of spatial frequency		CO2	Able to understand the importance of spatial domain analysis under influence of adverse effects like aliasing and noise signalling conditions.
	Introducing of techniques for beam forming and direction arrival estimation		CO3	Able to use beam forming techniques in various signal processing applications.
			CO4	Able to use direction of arrival estimation techniques in various signal processing applications.

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	1	0	0	1	0	0	0	0	0	0	0	2	0	1	0
2	CO2	1	2	2	2	0	0	0	0	0	0	0	1	2	0	2	0
3	CO3	0	2	2	1	2	0	0	0	0	0	0	2	2	2	2	0
4	CO4	0	2	0	1	2	0	0	0	0	0	0	2	2	2	2	0

	SYLLABUS		
No.	**Content**	**Hours**	**Cos**
I	Spatial signals: Array fundamentals, Array signal Model, Signals in space and time, spatial frequency, Direction vs. frequency, Wave fields, far field and near field signals. Sensor arrays: Spatial sampling, Nyquist criterion, Sensor arrays, Uniform linear arrays, Planar and random arrays, Array transfer (steering) vector, Array steering vector for ULA, Performance analysis, Broadband arrays.	08	CO1
II	Spatial frequency: Aliasing in spatial frequency domain, Spatial Frequency Transform, Spatial Domain Filtering, Beam forming, tapped Beam forming, Eigen analysis of the optimum beam former, spatially white signal.	10	CO2
III	Adaptive beam forming: Sample matrix inversion, Diagonal loading with the SMI beam former, Implementation of the SMI beam former, linearly constrained Beam formers, Partially Adaptive arrays, Side lobe cancellers, angle estimation, Beam splitting algorithms, Model based methods, Space-time adaptive array processing.	09	CO3
IV	Direction of arrival estimation: Non parametric methods – Beam forming and Capon methods, Resolution of Beam forming method, Subspace methods – MUSIC, Minimum Norm and ESPRIT TECHNIQUES, Spatial Smoothing.	09	CO4
	Total Hours	36	

Essential Readings

1. Harry L. Van Trees, "Optimum Array Processing (Detection, Estimation and Modulation Theory, Part-IV)", John Wiley & Sons, 2002.

2. D. G. Manolakis, V. K. Ingle and S. M. Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing," McGraw-Hill, New York, 2000.

Supplementary Readings

1. Dan E. Dugeon and Don H. Johnson, "Array Signal Processing: Concepts and Techniques", Prentice Hall, 1993.