Detailed Syllabus

Lecture-wise Breakup

Subject Code	10B1NEC731	**Semester Odd (Specify Odd/Even)**	Semester Summer Session 2021 - 2022 Month from: June 2021 – July 2021
Subject Name	Information Theory and Application		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	1. Ms. Neetu Singh
	Teacher(s) (Alphabetically)	1. Ms. Neetu Singh

Course Objectives:

• Establishing the definition of a quantity that can be a valid measurement of information, which should be consistent with a physical understanding of its properties.

• Developing relationship between the information and the source that generates it. This concept will be referred to as source information.

• Developing relationship between the information and the unreliable channel through which it is going to be transmitted. This concept leads to the definition of a very important parameter called the channel capacity.

• Application of information theory techniques in error-detection and correction.

Course Outcomes:

Students will have the concepts and gain knowledge on

• Entropy as basic measure of information.

• Source coding theorem and data compression algorithms.

• Mutual Information and Channel Capacity of communicational channel for information transmission.

• Channel coding theorem and information capacity theorem.

• Linear Block Codes.

• Cyclic Codes.

• Convolutional Codes

Module No.	Subtitle of the Module	Topics in the module	No. of Lectures for the module
1.	Review of Basic Probability	Probability spaces. Random variables. Distributions and densities. Functions of random variables. Statistical Averages. Inequalities of Markov and Chebyshev. Weak law of large numbers.	3
2.	Information Measure	Discrete entropy. Joint and conditional entropies. Entropy in the continuous case. Maximization of continuous entropy. Entropy of a bandlimited white Gaussian process.	5
3.	Data Compression	Uniquely decipherable and instantaneous codes. Kraft- McMillan inequality. Noiseless coding theorem. Construction of optimal codes.	4

4.	Data Transmission	Discrete memoryless channel. Mutual information and channel capacity. Shannon's fundamental theorem and its weak converse. Capacity of a bandlimited AWGN channel. Limits to communication – Shannon limit.	5
5.	Error Control Coding	Coding for reliable digital transmission and storage. Types of codes. Modulation and coding. ML decoding. Performance measures.	3
6.	Linear Block Codes	Algebra Background, Groups, Fields, Binary field arithmetic. Vector Spaces over GF(2). Generator and parity check matrices. Syndrome and error detection. Standard array and syndrome decoding. Hamming codes.	8
7.	Cyclic Codes	Polynomial representation, Rings and Rings of Polynomials, Systematic encoding. Cyclic encoding, Syndrome decoding. Shortened Cyclic Codes.	5
8.	Convolutional Codes	Generator Sequences. Distance Properties. Convolutional encoders. Optimal decoding of convolutional codes- the Viterbi algorithm. Performance and Error Analysis	5
9.	Turbo Codes	Introduction, Distance properties, Performance analysis, Design of the turbo codes, Iterative decoding of turbo codes.	5
		Total number of Lectures	**43**

Project Based Learning: Students will learn about the design and implementation of compression algorithms as well as error-correcting codes with the help of assignments.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	R.B. ASH: Information Theory, Dover, 1990.
2.	R.W. YEUNG: Information Theory and Network Coding, Springer, 2008.
3.	SHU LIN & D.J. COSTELLO: Error Control Coding, 2nd Edn, Pearson, 2004.
4.	T.K. MOON: Error Correction Coding, Wiley, 2006.
5.	A. POPOULIS: Probability, Random Variables and Stochastic Processes, Tata McGraw-Hill Edition, 2002**.**

Detailed Syllabus
Lecture-wise Breakup

Course Code	18B12EC411	**Semester Odd (specify Odd/Even)**	Semester Summer Session 2021 - 2022 Month from: June 2021 – July 2021
Course Name	Introduction to IOT		
Credits	3	**Contact Hours**	4

Faculty (Names)	**Coordinator(s)**	Dr. Gaurav Verma (62)
	Teacher(s) (Alphabetically)	

COURSE OUTCOMES		**COGNITIVE LEVELS**
C434-7.1	**Outline the basic concepts of IOT with networking and protocol considerations in IOT scenario.**	Understand (C2)
C434-7.2	**Identify various IOT hardware platforms and their utilization with various sensors and actuators.**	Apply (C3)
C434-7.3	**Experiment the basic concepts of python programming and make use of them in image processing, data analytics and machine learning applications.**	Apply (C3)
C434-7.4	**Examine various case studies and cloud platforms in an IOT scenario for monitoring, control and analysis.**	Analyze (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	IOT Basics and its Importance	Introduction to IOT (People Connecting to Things, Things Connecting to Things, Definition of IOT, History of IOT), IOT Components (Sensors & Actuators, Things, Communications, Networks, The Internet, Protocol Stack), Evolution of Connected Devices, IOT Applications, IOT Companies, Baseline Technologies (Machine to Machine (M2M) Communication, Cyber Physical Systems (CPS), Web of Things (WOT)), Address Crunch in IOT, IOT Terminologies (IOT Node, LAN, MAN & WAN, IOT Gateway & Proxy), IOT Network Configuration (Gateway Prefix Allotment, Impact of Mobility on Addressing, Concept of Tunneling, Multi-homing), IPv4 Versus IPv6.	6
2.	Basics of IOT Networking	Introduction to IOT Networking, Networking Standards and Technologies (Network Access & Physical Layer, Internet Layer, Transport Layer, The application layer), IOT Networking Protocols, Network Access and Physical layer IoT Network Technologies ((LPWAN (Low Power Wide Area Network), Cellular, Bluetooth Low Energy (BLE), RFID, NFC, Zigbee, Wifi, Ethernet), Internet layer IoT network technologies (IPv6, 6LoWPAN, and RPL),	6

		Application layer IoT network technologies (HTTP, HTTPS, MQTT, AMQP, and XMPP), IoT networking considerations and challenges, IoT Platforms Capabilities.	
3.	IoT supported Hardware platforms (Arduino) & data visualization using cloud.	Introduction to Arduino (Different Arduino boards, Arduino Uno board description and its pin configuration, Arduino IDE and program uploading, different functions related to GPIOs and special functions (PWM and Serial communication), Interfacing with Arduino using processing language (LED, Switch, Seven Segment, LCD, DC Motor, Relay, IR, LDR and DHT11 sensor), Interrupts, use of simulator and compiler, basics of HTML, Arduino supported IOT modules (Ethernet & Wifi Shield) and their configuration, Monitoring of sensor data on cloud and Web based controlling of actuators.	12
4.	Introduction to Python, Data Analytics, Machine Learning and Case Studies.	Introduction to python, python IDE, Data types, various programming constructs (loops, if, else etc.), operators, functions, modules, data handling (pandas), file operations, Image operations (PIL-pillow), data plotting in python (Matplotlib), basics of machine learning in python (Scikit) and related case studies.	10
5.	IoT supported Hardware platforms (Raspberry pi) & its Applications	Introduction to Raspberry pi (Raspberry pi different model comparison, Pin Configuration, Raspberry Pi operating system choices, Set up your Raspberry pi, Raspbian OS, Remote Access using SSH, Remote Access using TightVNC), Interfacing with Raspberry pi using python and use of open source libraries (LED, Switch, LCD, DC Motor, Relay, IR, LDR and DHT11 sensor), IOT Applications (Water management system, Weather monitoring station on cloud, Smart Agriculture System, Smart Energy meter, Pollution Monitoring system, Smart Dustbin management system.	8
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Assignments, Attendance & Quiz)
Total	**100**

Project Based Learning Component: This course teaches IoT using a building block approach, which allows one to visualize the requirement of an IoT framework and then to design it efficiently. IoT cuts across different application domain verticals ranging from civilian to defence sectors. These domains include agriculture, space, healthcare, manufacturing, construction, water, and mining, which are presently transitioning their legacy infrastructure to support IoT. The course will teach IoT based system design using IoT boards, namely Arduino, ESP8266, and Raspberry Pi. The course will introduce various interfacing techniques for popular input devices including sensors, output devices and communication protocols. It will also teach effective embedded programming techniques in python with application to image processing and Machine Learning. It will have a significant practical component, which will be achieved by providing real time demonstrations of various case studies based on IoT.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	"The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2.	"Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)

Detailed Syllabus

Course Code	17M15EC114	Semester Summer	Semester Summer Session 2021 - 2022 Month from: June 2021 – July 2021
Course Name	ECE DESIGN AND SIMULATION LAB -2		
Credits	1	Contact Hours	
Faculty (Names)	Coordinator(s)	Dr Amit Kumar Goyal	
	Teacher(s) (Alphabetically)	Dr Amit Kumar Goyal	

COURSE OUTCOMES		COGNITIVE LEVELS
CO1	Understand and Analyze the path loss exponent for wireless communication.	Analyzing (IV)
CO2	Design an efficient communication system having adequate signal strength for base station.	Applying (Level III)
CO3	Analyze the frequency reuse and handover probability for a given wireless communication system.	Applying (Level III)
CO4	Simulate the various performance metrics of the wireless communication system.	Analyzing (IV)

Module No.	Title of the Module	List of Experiments	CO
1	Introduction to Modelling of Wireless Channel	1. To understand the path loss prediction formula and Calculation of received signal strength as a function of distance of separation, antenna height and carrier frequency. **To understand the impact of :-** a) Transmitter Power, b) Path loss exponent, c) Carrier frequency, d) Receiver antenna height, e) Transmitter antenna height.	CO1
		2. Calculation of path loss exponent and variance of shadow fading.	CO1

2	Wireless Communication System Optimization	3. To find the 3dB beam-width of a base station antenna. (a) To study the horizontal beam pattern of the Base Station antenna and calculate the beamwidth for horizontal beam pattern (b) To study the vertical beam pattern of the Base Station antenna and calculate the beamwidth for vertical beam pattern	CO2
		4. To calculate the probability that the received signal level crosses a certain sensitivity level.	CO2
		5. To understand the concept of co-channel interference and hence Signal to Interference and Noise Ratio**. A. Downlink:** To calculate & plot SINR vs. distance at the Mobile Station for adaptation of the following parameters, (a) Shadowing effect, (b) Vertical Beam Pattern, **B. Uplink:** To calculate & plot SINR vs. distance at the base stations for different distance of two mobile stations from the base stations and different separation between them for adaptation of the following parameters, (a) Shadowing effect, (b) Vertical Beam Pattern,	CO2
		6. Understanding the impact of many different parameters influence the downlink C/I ratio. (a) Cell radios, (b) Tx power of B.S, (c) Frequency reuse, (d) Sectoring, (e) Shadowing effect, (f) B.S. height, (g) Path loss exponent, (h) Vertical beam tilt	CO2
3	Capacity Improvement Techniques	7. To understand the cellular frequency reuse concept fulfilling the following objectives: (a) Finding the co-channel cells for a particular cell. (b) Finding the cell clusters within certain geographic area**.**	CO3
		8. To study the effect of handover threshold and margin on SINR and call drop probability and handover probability	CO3

4	Analysis of various performance metrics of the wireless communication systems.	9. To study the outage probability, LCR & ADF in SISO for Selection Combining and MRC.	CO4
		10. To study the effect of delay spread on frequency selectivity.	CO4

Project Based Learning: ECE DESIGN AND SIMULATION LAB -2 is a lab course designed for integrated students. The course provides a thorough knowledge about various aspects of wireless communications system (WCS). This includes understanding and analysing the impact of various performance parameters on a designed WCS. Thus, students are provided a wide scope to do their projects in different modules of the course. The projects can be taken towards designing an efficient WCS. This includes optimization of various parameters like receiving and transmitting antenna height, transmitting power, estimating handoff probability to avoid call drop and to study outage probability, LCR & ADF in SISO for Selection Combining and MRC.

Evaluation Criteria

Components	Maximum Marks
Mid Viva	20
End Viva	20
TA	60
Total	100

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1	T. Rappaport, "Wireless Communication" prentice-hall, 2002.
2.	Gerd Keiser, Optical Fiber Communications, 3rd Edition, McGraw-Hill International edition, 2000.
3	John M. Senior, Optical Fiber Communications, 2nd Edition, PHI, 2002.
4.	D.K. Mynbaev, S.C. Gupta and Lowell L. Scheiner, Fiber Optic Communications, Pearson Education, 2005.
5.	Journal articles i.e. IEEE, Springer, IOPscience, Elsevier and Video lectures from nanohub, NPTEL, MIT video lectures
6.	http://fcmcvlab.iitkgp.ac.in/ http://vlabs.iitkgp.ernet.in/fcmc/#