Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

SYLLABUS FOR BACHELOR OF TECHNOLOGY IN ROBOTICS

(Effective from academic session 2020-21)

Semester-VIII

Subject Code: OE-ROB801A	**Category:** Open Elective Courses
Subject Name: Big Data Analysis	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: NA	

COURSE OBJECTIVES:

- Understand the Big Data Platform and its Use cases
- Provide an overview of Apache Hadoop
- Provide HDFS Concepts and Interfacing with HDFS
- Understand Map Reduce Jobs
- Provide hands on Hadoop Eco System
- Apply analytics on Structured, Unstructured Data.
- Exposure to Data Analytics with R.

COURSE OUTCOMES: The students will be able to:

- Identify Big Data and its Business Implications.
- List the components of Hadoop and Hadoop Eco-System
- Access and Process Data on Distributed File System
- Manage Job Execution in Hadoop Environment
- Develop Big Data Solutions using Hadoop Eco System
- Analyze Infosphere BigInsights Big Data Recommendations.
- Apply Machine Learning Techniques using R.

Pre- requisites: Should have knowledge of one Programming Language (Java preferably), Practice of SQL (queries and sub queries), exposure to Linux Environment.

UNIT I: INTRODUCTION TO BIG DATA AND HADOOP

Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets.

UNIT II: HDFS (Hadoop Distributed File System) The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

UNIT III: Map Reduce Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

Unit IV: Hadoop Eco System Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL: Introduction

UNIT V: Data Analytics with R Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.

Text Books

• Tom White “Hadoop: The Definitive Guide” Third Edit on, O’reily Media, 2012.
• Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

References

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis”, Springer, 2007.
2. Jay Liebowitz, “Big Data and Business Analytics” Auerbach Publications, CRC press (2013)
3. Tom Plunkett, Mark Hornick, “Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop”, McGraw-Hill/Osborne Media (2013), Oracle press.
4. Anand Rajaraman and Jef rey David Ulman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
5. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley & sons, 2012.
6. Glen J. Myat, “Making Sense of Data”, John Wiley & Sons, 2007
7. Pete Warden, “Big Data Glossary”, O’Reily, 2011.
8. Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013.
9. ArvindSathi, “BigDataAnalytics: Disruptive Technologies for Changing the Game”, MC Press, 2012
10. Paul Zikopoulos, Dirk DeRoos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corigan , "Harness the Power of Big Data The IBM Big Data Platform ", Tata McGraw Hill Publications, 2012

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN ROBOTICS

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Subject Code: OE-ROB801B	**Category:** Open Elective Courses
Subject Name: Robotics	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: NA	

Course Objective:

To impart knowledge about the engineering aspects of Robots and their application

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Basic concepts- Robot anatomy- Manipulators- kinematics: Forward and inverse kinematics- Precision movement, robot specifications and Work volume, Types of Robot drives- Basic robot motions- Point to point control, continuous path contour.	8
2	End Effectors: End effectors- classification- mechanical, magnetic, vacuum and adhesive gripper- gripper force analysis and design. Robot control- Unit control system concept- servo and non-servo control of robot joints, adaptive and optimal control.	7
3	Sensors: Sensor devices, Types of sensors- contact, position and displacement sensors, Force and torque sensors- Proximity and range sensors- acoustic sensors- Robot vision systems- Sensing and digitizing- Image processing and analysis.	6
4	Robot Programming: Robot language classification- programming methods- off and on line programming- Lead through method- Teach pendent method- VAL systems and language, simple program.	8
5	Industrial Application: Application of robots- Material handling- Machine loading and unloading, Assembly, Inspection, Welding, Spray painting, Mobile robot, Microbots- Recent developments in robotics- safety consideration.	7

Course Outcome:

1. To familiarize the Basics of robots Control system.
2. To familiarize the end effectors, Sensor technology and Industrial application of robot.

Learning Resources:

1. S.R. Deb, Robotics technology and flexible automation, McGraw Hill publishing company limited, New Delhi, 1994.
2. M.P. Groover. Industrial Robotics Technology Programming and Applications, McGraw Hill Book Co, Singapore, 1987.

3. S.K. Saha, Introduction to Robotics, McGraw-Hill Publication, 2014.
4. Y. Koren, Robotics for Engineers, McGraw Hill, New York, 1985.
5. P.G. Ranky and C.Y. Ho, Robots Modelling Control and Applications with Software, Springer Verlag, 1985.
6. J.J. Craig, Introduction to Robotics, Addison-Wesley, 2009.
7. R.J. Schilling, Fundamentals of Robotics Analysis and Control, Prentice Hall of India, 1996.
8. T. Yoshikawa, Foundations of Robotics Analysis and Control, Prentice Hall of India, 2010.
9. K.S. Fu, R.C. Gonzales and C.S.G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill, 1997.
10. W. Stadler, Analytical Robotics and Mechatronics, McGraw Hill Book Co., 1995.

Subject Code: OE-ROB801C	**Category:** Open Elective Courses
Subject Name: Web Technology	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: NA	

Web Development:
HTML, Structure, Tags, Lists, Table, Link and its types, Images, Form, Frame, Style sheets and its type

Introduction to Java:
Java and Java applications, Java Virtual Machine(JVM), Java Runtime Environment(JRE)Java Development Kit(JDK,) Byte code, Java characteristics, Object oriented Programming, Simple java programs, Data types, Operators, Expressions, control statements, Selection statements, Iteration statements, Jump statements

Classes, Inheritance:
Classes in java, declaring a class, creating instances of class, Constructors, Argument Passing, use of static keyword, Inner class. Method overloading, Inheritance, use of super keyword, Method overriding, Abstract class, Dynamic method dispatch, use of final keyword

Interface, Package:
Package, Access control mechanism, Interface, Dynamic Method look up

Exception Handling:
Java Exception Handling Mechanism, try, catch, throw, throws and finally, Exception types, Built in Exceptions: checked and unchecked exceptions, User defined Exceptions

String Handling:
String and String Buffer, Constructors, String operations : character extractions, String comparisons, searching, strings, modifying a string. To String() and valueOf() methods, String Buffer operations

Java I/O Stream:
I/O basics, Byte stream, Character stream, Reading console input, Writing console output, Reading and writing files

Java Utility package:

Collection overview, Collection interfaces, Collection classes: ArrayList, LinkedList, Accessing a collection using, iterator and for-Each statement

Applet:

Applet class, Applet architecture, Applet Skeleton, Life cycle methods, setForeground() and set Bachground()methods, Using the status window,HTML Applet tag, Passing parameters to an applet, GetCodebase() and Get Documentbase() methods.

Event Handling and AWT:

Delegation Event Model, Event classes, Sources of Events, Event Listener interfaces,Event handling using adapter class, Inner and anonymous class, AWT classes: Label, Button, TextField etc.

Text Book

1. Java-The Complete Reference, Herbert Schildt, 9th Edition, McGraw Hill Education 2014

Reference Book

1. HTML- Complete Reference, Powell, 3rd Edition, TMH 2007
2. Core Java-An Integrated Approach, Dr. R.Nageswara Rao, Dreamtech 2015

Course Outcome: At the end of the course, the students will be able to:

1.Design good web pages using different tags, tables, forms, frames and style sheets supported by HTML.
2.Implement, compile, test and run Java programs, comprising more than one class, to address a particular software problem.
3.Demonstrate the ability to employ various types of selection statements and iteration statements in a Java program.
4.Be able to leverage the object-oriented features of Java language using abstract class and interface.
5.Be able to handle errors in the program using exception handling techniques of Java.
6.Design applets as per the requirements with event handling facility.

Subject Code: OE-ROB802A	**Category:** Open Elective Courses
Subject Name: Micro-electronics and VLSI Design	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: NA	

Introduction to CMOS circuits: MOS Transistors, MOS transistor switches, CMOS Logic, The inverter, Combinational Logic, NAND gate, NOT Gate, Compound Gates, Multiplexers, Memory-Latches and Registers. [6L]

Processing Technology: Silicon Semiconductor Technology- An Overview, wafer processing, oxidation, epitaxy deposition, Ion-implantation and diffusion, The Silicon Gate Process- Basic CMOS Technology, basic n-well CMOS process, p-well CMOS process, Twin tub process, Silicon on insulator, CMOS process Enhancement-Interconnect, circuit elements, 3-D CMOS. Layout Design Rule: Layer Representations, CMOS n-well Rules, Design Rule of background scribe line, Layer Assignment, SOI Rule [10L].

Power Dissipation: Static dissipation, Dynamic dissipation, short-circuit dissipation, total power dissipation. Programmable Logic, Programmable Logic structure, Programmable interconnect, and Reprogramable Gate Array: Xilinx Programmable Gate Array, Design Methods: Behavioural Synthesis, RTL synthesis [8L]

Placement: placement: Mincut based placement – Iterative improvement placement simulated annealing. Routing: Segmented channel routing – maze routing – routability and routing resources – net delays. [5L]

Verification and Testing: Verification Versus Testing, Verification: logic simulation design validation – timing verification – Testing concepts: failures – mechanisms and faults – fault coverage – ATPG methods – types of tests – FPGAs – programmability failures – design for testability. [5L]

Overview of VHDL [5L]

Text Book:

1. "Digital Integrated Circuit", J.M.Rabaey, Chandrasan, Nicolic, Pearson
2. "CMOS Digital Integrated Circuit", S.M.Kang & Y.Leblebici,
TMH 3."Modern VLSI Design" Wayne Wolf, Pearson
4."Algorithm for VLSI Design & Automation", N.Sherwani, Kluwer
5." VHDL", Bhaskar, PHI

References:

1. "Digital Integrated Circuits" Demassa & Ciccone, Willey Pub.
2. "Modern VLSI Design: system on silicon" Wayne Wolf; Addison Wesley Longman Publisher
3. "Basic VLSI Design" Douglas A. Pucknell & Kamran Eshranghian; PHI
4. "CMOS Circuit Design, Layout & Simulation", R.J.Baker, H.W.Lee, D.E. Boyee, PHI

Subject Code: OE-ROB802B	**Category:** Open Elective Courses
Subject Name: Microwave Integrated Circuits	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: NA	

Introduction: Introduction to Microwave Integrated Circuits (MIC) and Monolithic Microwave Integrated Circuits (MMICs), their advantages over discrete circuits, MMIC fabrication techniques, Thick and Thin film technologies and materials, encapsulation and mounting of active devices in MIC and MMIC.

Planar Transmission Lines-I: Strip line & microstrip line, field configurations, quasi-TEM mode in microstrip line, analysis of microstrip transmission line, concept of effective dielectric constant, impedance of Strip line & microstrip line, dispersion and losses in microstrip line, discontinuities in microstrip.

Planar Transmission Lines-II: Slot Line, approximate analysis and field distribution of slot line, transverse resonance method and evaluation of slot line impedance, comparison with microstrip line. Fin lines & Coplanar Lines, analysis of Fin lines by transverse resonance method, conductor loss in Fin lines, coplanar wave guide (CPW).

Parallel-coupled Microstrip Lines and Power Dividers: Coupled microstrip lines, even mode and odd mode characteristic impedances, semi-empirical formulae for coupled line parameters, coupled-region length, coupler directivity, crosstalk between microstrip lines, design of microstrip branch-line power divider and rat-race ring power divider.

MIC Measurement, Testing and Applications: MIC measurement system, microwave test fixtures and probes, measurement techniques of S- parameters, noise measurement.

Text Book

1. Microstrip Lines and Slot Lines - K.C. Gupta, R. Garg., I. Bahl, P. Bhartia, Artech House, 2nd Ed., 1996.
2. Foundation for Microstrip Circuit Design-T. C. Edwards, John Wiley & Sons Ltd, 2nd Ed., 1992.

Reference Book

1. Stripline-like Transmission lines for Microwave Integrated Circuits, B. Bhat, S. K. Koul, Wiley Eastern Ltd, 1st Ed., 1989.
2. Microwave Integrated Circuits, K.C. Gupta and A. Singh, Wiley Eastern Limited, 1st Ed., 1975.

Course Outcome: At the end of the course, the students will be able to:

1. Analyze the fabrication techniques of MIC and MMIC, use of active devices with MIC and MMIC, differentiate between MIC and MMIC.
2. Analyze and design strip lines and micro strip lines, and model the discontinuities in those lines.
3. Analyze and design slot lines, fin lines, coplanar lines and coplanar wave-guides
4. Design parallel coupled lines for couplers and power divider circuits.
5. Differentiate between various measurement techniques associated with planartransmission lines

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Subject Code: OE-ROB802C	**Category:** Open Elective Courses
Subject Name: Nano Electronics	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: NA	

Introduction to nanotechnology, meso structures, Basics of Quantum Mechanics: Schrodinger equation, Density of States. Particle in a box Concepts, Degeneracy. Band Theory of Solids. Kronig Penny Model. Brillouin Zones.

Shrink-down approaches: Introduction, CMOS Scaling, The nanoscale MOSFET, Finfets, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.),

Resonant Tunneling Diode, Coulomb dots, Quantum blockade, Single electron transistors, Carbon nanotube electronics, Band structure and transport, devices, applications, 2D semiconductors and electronic devices, Graphene, atomistic simulation

Text/ Reference Books:

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH, 2003.
3. K.E. Drexler, Nanosystems, Wiley, 1992.
4. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
5. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand various aspects of nano-technology and the processes involved in making nano components and material.
2. Leverage advantages of the nano-materials and appropriate use in solving practical problems.
3. Understand various aspects of nano-technology and theprocesses involved in making nano components and material.
4. Leverage advantages of the nano-materials and appropriate use in solving practical problems

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Subject Code: PE –ROB801A	**Category:** Professional Elective Courses
Subject Name: Multi Agent Intelligent Systems	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: NA	

Unit	Content	Hrs/Unit
1	Introduction: what is an agent?: agents and objects; agents and expert systems; agents and distributed systems; typical application areas for agent systems.	3
2	Intelligent Agents: the design of intelligent agents - reasoning agents (e.g. AgentO), agents as reactive systems (e.g. subsumption architecture); hybrid agents (e.g. PRS); layered agents (e.g. Interrap) a contemporary (Java-based) framework for programming agents (e.g. the Jack language, the JAM! system).	9
3	Multi-Agent Systems: Classifying multi-agent interactions - cooperative versus non-cooperative; zero-sum and other interactions; what is cooperation? how cooperation occurs - the Prisoner's dilemma and Axelrod's experiments; Interactions between self- interested agents: auctions & voting systems: negotiation; Interactions between benevolent agents: cooperative distributed problem solving (CDPS), partial global planning; coherence and coordination; Interaction languages and protocols: speech acts, KQML/KIF, the FIPA framework.	12
4.	Advanced topics: One issue selected from the contemporary research literature, perhaps by guest lecturer.	9

Text book and Reference books:

1. An Introduction to Multi Agent Systems - Second Edition. Michael Wooldridge (Wiley, 2009)
2. Programming Multi-agent Systems in Agent Speak Using Jason. Rafael H. Bordini, Jomi Fred Hubner and Michael Wooldridge (Wiley, 2007)

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Subject Code: PE-ROB801B	**Category:** Professional Elective Courses
Subject Name: Internet of Things	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Sensors, System Integration, Cloud and Network Security	

Objectives:

The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-life IoT based projects.

Course Content:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to IoT:** Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT.	7
2	**Elements of IoT**: Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/ Node.js/ Arduino) for Communication Protocols- MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.	8
3	**IoT Application Development:** Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.	15
4	**IoT Case Studies:** IoT case study and mini project based on Industrial automation/ Transportation/ Agriculture/ Healthcare/ Home Automation	6

Course Outcomes:

At the end of the course, the student will be able to:

1. Understand internet of Things and its hardware and software components
2. Interface I/O devices, sensors & communication modules
3. Remotely monitor data and control devices, and develop real life IoT based projects

Learning Resources:

1. V. Madisetti and A. Bahga, Ïnternet of Things, A Hands on Approach, University Press, 2015.
2. S.R.N. Reddy, R. Thukral and M. Mishra, Introduction to Internet of Things: A Practical Approach, ETI Labs, 2017.
3. P. Raj and A.C. Raman, The Internet of Things: Enabling Technologies, Platforms and Use Cases, CRC Press, 2017.
4. J. Jose, Internet of Things, Khanna Publishing House, New Delhi, 2018.
5. A. McEwen, Designing the Internet of Things, Wiley, 2013.
6. R. Kamal, Internet of Things: Architecture and Design, McGraw Hill, 2017.
7. C. Pfister, Getting Started with the Internet of Things, O Reilly Media, 2011.

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Subject Code: PE-ROB801C	**Category:** Professional Elective Courses
Subject Name: Cloud Computing	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Basic Programming in Python, Data Structures	

Unit	Content	Hrs/Unit
1	**Definition of Cloud Computing and its Basics(Lectures).** Defining a Cloud, Cloud Types – NIST model, Cloud Cube model, Deployment models (Public , Private, Hybrid and Community Clouds), Service Platform as a Service, Software as a Service with examples of services/ service providers, models – Infrastructure as a Service, Cloud Reference model, Characteristics of Cloud Computing – a shift in paradigm Benefits and advantages of Cloud Computing, A brief introduction on Composability, Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications, Connecting to the Cloud by Clients, IaaS – Basic concept, Workload, partitioning of virtual private server instances, Pods, aggregations, silos PaaS – Basic concept, tools and development environment with examples SaaS - Basic concept and characteristics, Open SaaS and SOA, examples of SaaS platform Identity as a Service (IDaaS) Compliance as a Service (CaaS)	9
2	**Use of Platforms in Cloud Computing** Concepts of Abstraction and Virtualization Technologies Types of virtualization (access application, CPU, storage), Mobility patterns (P2V, V2V, V2P, P2P, D2C, C2C, C2D, D2D) Load Balancing and Virtualization: Basic Concepts, Network resources for load balancing, Advanced load balancing (including Application Delivery Controller and Application Delivery Network), Mention of The Google Cloud as an example of use of load balancing Hypervisors: Virtual machine technologyand types, VMware vSphere Machine Imaging (including mention of Open Virtualization Format – OVF) Porting of applications in the Cloud: The simple Cloud API and AppZero Virtual Application appliance, Concepts of Platform as a Service, Definition of services, Distinction between SaaS and PaaS (knowledge of Salesforce.com and Force.com), Application development ,Use of PaaS Application frameworks,	12
3	Discussion of Google Applications Portfolio – Indexed search, Dark Web, Aggregation and disintermediation, Productivity applications and service, AdWords, Google Analytics, Google Translate, a brief discussion on Google Toolkit (including introduction of Google APIs in brief), major features of Google App Engine service., Discussion of Google Applications Portfolio – Indexed search, Dark Web, Aggregation and disintermediation, Productivity applications and service, AdWords, Google Analytics, Google Translate, a brief discussion on Google Toolkit (including introduction of Google APIs in brief), major features of Google App Engine service, Windows Azure platform: Microsoft's approach, architecture, and main elements, overview of Windows Azure AppFabric, Content Delivery	7

	Network, SQL Azure, and Windows Live services,	
4	Discussion of Google Applications Portfolio – Indexed search, Dark Web, Aggregation and disintermediation, Productivity applications and service, AdWords, Google Analytics, Google Translate, a brief discussion on Google Toolkit (including introduction of Google APIs in brief), major features of Google App Engine service., Discussion of Google Applications Portfolio – Indexed search, Dark Web, Aggregation and disintermediation, Productivity applications and service, AdWords, Google Analytics, Google Translate, a brief discussion on Google Toolkit (including introduction of Google APIs in brief), major features of Google App Engine service, Windows Azure platform: Microsoft's approach, architecture, and main elements, overview of Windows Azure AppFabric, Content Delivery Network, SQL Azure, and Windows Live services,	8
5	**Concepts of Services and Applications:** Service Oriented Architecture: Basic concepts of message-based transactions, Protocol stack for an SOA architecture, Event-driven SOA, Enterprise Service Bus, Service catalogs, Applications in the Cloud: Concepts of cloud transactions, functionality mapping, attributes, System abstraction and Cloud Bursting, Applications and Cloud APIs Cloud-based Storage: Cloud storage definition – Manned and Unmanned Webmail Services: Cloud mail services including Google Gmail, Mail2Web, Windows Live Hotmail, Yahoo mail, concepts of Syndication services	10

Text book and Reference books:

1. Cloud Computing Bible by Barrie Sosinsky, Wiley India Pvt. Ltd, 2013
2. Mastering Cloud Computing by Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, McGraw Hill Education (India) Private Limited, 2013
3. Cloud computing: A practical approach, Anthony T. Velte, Tata Mcgraw-Hill
4. Cloud Computing, Miller, Pearson
5. Building applications in cloud: Concept, Patterns and Projects, Moyer, Pearson
6. Cloud Computing – Second Edition by Dr. Kumar Saurabh, Wiley India

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Subject Code: PE –ROB802A	**Category:** Professional Elective Courses
Subject Name: Mobile Communication and Networks	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: NA	

Cellular Concepts-Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Wireless Standards: Overview of 2G and 3G cellular standards.

Signal Propagation-Propagation mechanism- reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Fading Channels-Multipath and small scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate.

Capacity of flat and frequency selective channels. Antennas-Antennas for mobile terminal-monopole antennas, PIFA, base station antennas and arrays.

Multiple access schemes-FDMA, TDMA, CDMA and SDMA. Modulation schemes- BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM.

Receiver structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit Diversity-Altamonte scheme.

MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing tradeoff. Performance measures- Outage, average snr, average symbol/bit error rate. System examples- GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA.

Text/Reference Books:

1. WCY Lee, Mobile Cellular Telecommunications Systems, McGraw Hill, 1990.
2. WCY Lee, Mobile Communications Design Fundamentals, Prentice Hall, 1993.
3. Raymond Steele, Mobile Radio Communications, IEEE Press, New York, 1992.
4. AJ Viterbi, CDMA: Principles of Spread Spectrum Communications, Addison Wesley, 1995.
5. VK Garg &JE Wilkes, Wireless & Personal Communication Systems, Prentice Hall, 1996.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the working principles of the mobile communication systems.
2. Understand the relation between the user features and underlying technology.
3. Analyze mobile communication systems for improved performance

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SYLLABUS FOR BACHELOR OF TECHNOLOGY IN ROBOTICS

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Subject Code: PE –ROB802B	**Category:** Professional Elective Courses
Subject Name: Antennas and Propagation	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: NA	

Fundamental Concepts- Physical concept of radiation, Radiation pattern, near-andfar-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.

Radiation from Wires and Loops- Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.

Aperture and Reflector Antennas-Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas.

Broadband Antennas- Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas.

Micro strip Antennas- Basic characteristics of micro strip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.

Antenna Arrays-Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method.

Basic Concepts of Smart Antennas-Concept and benefits of smart antennas, fixed weight beam forming basics, Adaptive beam forming.
Different modes of Radio Wave propagation used in current practice.

Text/Reference Books:

1. J.D. Kraus, Antennas, McGraw Hill, 1988.
2. C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982.
3. R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985.
4. R.C. Johnson and H. Jasik, Antenna Engineering Handbook, McGraw ill, 1984.
5. I.J. Bahl and P. Bhartia, Micro Strip Antennas, Artech House, 1980.
6. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill, 2005
7. R.E. Crompton, Adaptive Antennas, John Wiley

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the properties and various types of antennas.
2. Analyze the properties of different types of antennas and their design.
3. Operate antenna design software tools and come up with the design of the antenna of required specifications.

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

SYLLABUS FOR BACHELOR OF TECHNOLOGY IN ROBOTICS

(Effective from academic session 2020-21)

Subject Code: PE –ROB802C	**Category:** Professional Elective Courses
Subject Name: Fiber Optic Communication	**Semester:** Eight
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: NA	

Introduction to vector nature of light, propagation of light, propagation of light in a cylindrical dielectric rod, Ray model, wave model.

Different types of optical fibers, Modal analysis of a step index fiber. Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers and measurement techniques like OTDR.

Optical sources - LEDs and Lasers, Photo-detectors - pin-diodes, APDs, detector responsivity, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties.

Optical switches - coupled mode analysis of directional couplers, electro- optics

witches. Optical amplifiers - EDFA, Raman amplifier.

WDM and DWDM systems. Principles of WDM networks.

Nonlinear effects in fiber optic links. Concept of self-phase modulation, group velocity dispersion and solition based communication.

Text/Reference Books

1. J. Keiser, Fibre Optic communication, McGraw-Hill, 5th Ed. 2013 (Indian Edition).
2. T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
3. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
4. S.E. Miller and A.G. Chynoweth, eds., Optical fibers telecommunications, Academic Press, 1979.
5. G. Agrawal, Nonlinear fibre optics, Academic Press, 2nd Ed. 1994.
6. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1997
7. F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York (1990).

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the principles fiber-optic communication, the components and the bandwidth advantages.
2. Understand the properties of the optical fibers and optical components.
3. Understand operation of lasers, LEDs, and detectors
4. Analyze system performance of optical communication systems
5. Design optical networks and understand non-linear effects in optical fibers