BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ODISHA

ROURKELA

Curriculum and Syllabus

B. Tech (Electronics and Communication Engineering/ Electronics and Tele Communication Engineering) from the Admission Batch

2018-19

Semester (6th)

Sixth Semester							
Theory							
Sl. No.	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**	**University Marks**	**Internal Evaluation**
1	PC	RCS6C001	Microwave Engineering	3-0-0	3	100	50
2	PC	RCS6C002	Wireless Communication	3-0-0	3	100	50
3	BS		Optimization in Engineering	3-0-0	3	100	50
4	PE		Antenna Engineering	3-0-0	3	100	50
			Micro Electronic Mechanical Systems	3-0-0			
			Biomedical Instrumentation	3-0-0			
5	OE		Artificial Intelligence and Machine Learning	3-0-0	3	100	50
			Renewable Power Generation Systems	3-0-0			
			Data Communication and Computer Networks	3-0-0			
6	MC*	RIK6F001	Essence of Indian Knowledge Tradition - I	3-0-0	0	-	100 (Pass mark is 37)
Total Credit (Theory)					**15**		
Total Marks						**500**	**250**
Practical							
1	PC	RCS6C201	Microwave Engineering Lab	0-0-3	2		100
2	PC	RCS6C202	Wireless Communication Lab	0-0-3	2		100
3	PSI		Future-ready Contributor Program	0-0-3	2		100
4	PSI		Seminar - I	0-0-3	1		100
Total Credit (Practical)					**7**		
Total Semester Credit					**22**		
Total Marks							**400**
SUMMER ENTERNSHIP TRAINING FOR 45 DAYS							

***Mandatory Non-Credit Courses (MC) result will be reflected with Pass (P) / Fail (F) grade. Thus the grade obtained will not be affecting the grade point average. However it shall appear on the grade sheet as per AICTE rule.**

6th Semester	RCS6C001	Microwave Engineering	L-T-P 3-0-0	3 Credits

Module I: **(10 hours)**

High Frequency Transmission lines and Wave guides : The Lumped –Element Circuit model for a Transmission line. Wave propagation. The lossless line. Field Analysis of Co-ax Transmission Lines. R, L. C. G parameters of Co-ax& Two wire Transmission Lines. Terminated lossless transmission line. Transmission line as circuit element. The Smith Chart. Solution of Transmission line problems using Smith Chart. Single Stub and Double Stub matching. Lowloss line.

Wave guides : Rectangular waveguide, Field solution for TE and TM modes, Field patterns power flow through waveguide. Attenuation due to conductor and dielectric losses. Design of Rectangular waveguide to support Dominant TE10 only.

Module II: **(10 hours)**

TEM mode in Co-ax line. Cylindrical waveguide - Dominant Mode. Design of Cylindrical Waveguide to support Dominant TE11 mode. Microwave Resonator : Rectangular Waveguide Cavities. Resonant frequencies and of Cavity Supporting. Dominant mode only. Excitation of waveguide and Resonators (in princle only) Waveguide Components: Power Dividers and Directional Couplers : Basic Properties. The T-Junction Power Divider. Waveguide Directional Couplers. Fixed and Precision Variable Attenuator. Ferrite, Fermle Isolator . Principle of Operationing.

Module III: **(8 hours)**

Principle of Operation as an amplifier at high frequency, HEMT Amplifier, Concept of Doherty Amplifier and its use at high frequency, Gunn Oscillator Principle and performance Simple Analysis Electron – field interaction, Mixer: Linear Mixer Operation, active devices to use as mixer

Module IV: **(6 hours)**

Microwave Antennas: Horn Antennas : E-And H- Plane Horns. Radiation Patterns. Pyramidal Horn. Gain of Horn Antenna. Paraboloid Reflector Antenna – Simple Analysis , Radiation Pattern in principal Planes. Gain and Bandwidth of Reflector Antenna. Microwave Propagation : Line of sight propagation. Attenuation of Microwaves by Atmospheric gases, Water Vapour & Precipitates. Microwave Measurement : Measurement of Admittance . Measurement of Gain of a Horn Antenna.

Books:

[1] Microwave Engineering by D. M. Pozor , 2nd Edition. John Willy & Sons. Selected portions from Chapter 2, 3, 4, 6, 7 & 9.
[2] Principles of Microwave Engineering By Reich, Oudong and Others.
[3] Microwave Device and Circuit, 3rd Edition, Sammuel Y., Liao, Perason
[4] Microwave Devices and Circuits, G S N Raju

Digital Learning Resources:

Course Name:	Microwave Engineering
Course Link:	https://nptel.ac.in/courses/108/103/108103141/
Course Instructor:	Dr. Ratnajit Bhattacharjee, IIT, Guwahati

Course Name:	Microwave Theory and Techniques
Course Link:	https://nptel.ac.in/courses/108/101/108101112/
Course Instructor:	Prof. Girish Kumar, IIT, Bombay

6th Semester		Wireless Communication	L-T-P 3-0-0	3 Credits

Module I: **(5 hours)**

History of wireless communication: Concept of mobile and personal communication, wireless cellular platform, the design fundamentals of cellular networks, frequency reuse, spectrum capacity enhancement techniques, co-channel and adjacent channel interference, location management, handoff management; Concept of mobile IP for mobility management issues.

Module II: **(10 hours)**

Propagation Models for Wireless Networks: Two-ray ground reflection model, a micro-cell propagation model, a macro-cell propagation model, shadowing model, large scale path loss and shadowing, multi path effects in mobile communication, linear time variant channel model; Concept of coherent bandwidth, Coherent time, Doppler Shift - Effect of velocity of the mobile, models for multi path reception, mobile communication antennas.

Module III: **(7 hours)**

Multiple access techniques in wireless communications: frequency division multiple access technology (FDMA), time division multiple access (TDMA), space division multiple access (SDMA), code division multiple access (CDMA); spectral efficiency of different wireless access technologies, spectral efficiency in FDMA system, spectral efficiency in TDMA system, spectral efficiency for DS-CDMA system.

Module IV: **(10 hours)**

Second Generation Mobile Networks-GSM: Architecture and protocols, access technology, call set up procedure, 2.5 G networks; evolution to GPRS, concept of data communication on GPRS, session management and PDP Context, data transfer through GPRS network and routing, concept of LTE, WiMax, 4G and 5G

Module V: **(8 hours)**

Applications of different RF bands: ranges • Brief about various applications of RF technology like WiFi, Bluetooth, Air traffic control, GPS navigation system, satellite systems, mobile networks, radio astronomy and remote sensing, 5G technology. • LTE-WiFi Radio Level Aggregation (LWA).

Books:

[1] Wireless Communications- Principles and Practice, T S Rappaport, Pearson Education India, Second Edition.
[2] Wireless Communication and Networks, Upen Dalal, Oxford university Press, First Edition, 2015.
[3] Wireless Communication and Networks 3G and Beyond, Iti Saha Misra, Tata McGraw Hill Education Pvt. Ltd, Second Edition, 2009.
[4] Mobile Communication Engineering – Theory and Applications W C Y Lee, TMH Publication, Second Edition, 2008.
[5] Wireless Communication, Andrea Goldsmith, Cambridge University Press, 2005
[6] Fundamentals of Wireless Communication, David Tse and Pramod Viswanath, Cambridge University Press, 2005

Digital Learning Resources:

Course Name:	Wireless Communication
Course Link:	https://nptel.ac.in/courses/117/102/117102062/
Course Instructor:	Prof. Ranjan Bose, IIT, Delhi

Course Name:	Introduction to Wireless and Cellular Communication
Course Link:	https://nptel.ac.in/courses/108/106/106106167/
Course Instructor:	Prof. David KoilPillai, IIT, Madras

6th Semester		Optimization in Engineering	L-T-P 3-0-0	3 Credits

Module I: **(10 Hours)**

Idea of Engineering optimization problems, Classification of optimization algorithms, modeling of problems and principle of modeling. Linear Programming: Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method, Sensitivity analysis in linear programming.

Module II: **(10 Hours)**

Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method. **Assignment problems:** Hungarian method for solution of Assignment problems. Integer Programming: Branch and Bound algorithm for solution of integer programming problems.

Module III: **(12 Hours)**

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method. Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming.

Module IV: **(6 Hours)**

Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, multiple server, Finite sources, Queue discipline.

Books:

[1] Operations Research- Principle and Practice, A. Ravindran, D. T. Philips, J. Solberg, Second edition, Wiley India Pvt Ltd.
[2] Operation Research, Prabhakar Pai ,Oxford University Press
[3] Optimization for Engineering Design, Kalyanmoy Deb, PHI Learning Pvt Ltd.
[4] Operations Research, H.A.Taha, A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, Pearson Education, Eighth Edition.
[5] Engineering Optimization, S S Rao, New Age International Pvt Ltd, 2003.
[6] Linear and Non-linear Optimization, **S**tephen G. Nash, A. Sofer, McGraw Hill, 2nd Edition.
[7] Engineering Optimization, A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Wiley India Pvt. Ltd, Second edition.
[8] Operations Research, F.S.Hiller, G.J.Lieberman, Tata McGraw Hill, Eighth Edition, 2005.
[9] Operations Research, P.K.Gupta, D.S.Hira, S.Chand and Company Ltd, 2014.

Digital Learning Resources:

Course Name	Constrained and Unconstrained Optimization
Course Link	https://nptel.ac.in/courses/111/105/111105100/
Course Instructor	Prof. A. Goswami and Prof. D. Chakraborty, IIT Kharagpur

6th Semester		Antenna Engineering	L-T-P 3-0-0	3 Credits

Module-I: **(10 Hours)**

Principles of Radiation, Retarded Vector Magnetic Potential. Radiation field from Current element. Radiation Resistance, Current Distribution, on a thin Wire. Half wave dipole and Quarter wave monopole. Two-element array. Principle of Pattern Multiplication. Linear Array. Broadside and end fire patterns. Antenna Gain, effective length of an antenna. Input Impedance. Balun.

Module-II: **(10 Hours)**

Folded Dipole, Yagi Antenna. Frequency Independent Antenna. Log Periodic Dipole array. Secondary Sources and Aperture Antennas . Magnetic Current. Principles of Images. The Equivalence Theorem. Radiation form Huygen's Sources. Radiation from open end of a Co-axial line. Aperture in an absorbing screen. Radiation through an aperture in a perfectly conducting screen. Babinet's Principle– Complementary Screen. A thin slot in an infinite Screen. Slot antenna on a rectangular wave guide wall.

Module-III: **(8 Hours)**

Horn Antennas – Pyramidal &Sectoral Horn. Radiation Pattern and Gain of horn antenna. Parabolic Reflector Antenna Principle, analysis, Radiation Pattern and Gain. Principles of Casse grain Antenna. Inducted EMF method of Calculating Input Impedance of wire antenna. Mutual Impedance between two dipoles.

Module IV **(8 Hours)**

Microstrip Antenna – Basic Characteristics, Rectangular Patch, Circular Patch, Microship Array Antenna. Electronic Scanning Antenna- Phase Scanning, Frequency Scanning and Beam switching Antenna Measurements – Radiation Pattern, Gain and Input Impedance. 5G Antenna

Books:

[1] Electromagnetic Wave and Radiating Systems by E. C Jordan and K. G. Balmain, 2nd Edition , PHI. Ch. 10,11,12,13,14 and 15.
[2] Antennas Theory - Analysis and Design By C Balamis, 2nd Edition, John Willey & Sons. Selected portion Ch. 11,12,13, 15 and 16.
[3] Antenna Engineering by J. D. Krauss.
[4] Antenna Engineering by W. L. Weeks
[5] Antennas and Wave Propagation by G. S. N. Raju, Pearson Education.
[6] Antenna & Wave Propagation by R.E. Collins.

Digital Learning Resources:

Course Name: Antennas
Course Link: https://nptel.ac.in/courses/108/101/108101092/
Course Instructor: Prof. Girish Kumar, IIT, Bombay

Course Name: Analysis and Design Principles of Microwave Antennas
Course Link: https://nptel.ac.in/courses/108/105/108105114/
Course Instructor: Dr. Amitabha Bhattacharya, IIT Kharagpur

6th Semester		Micro Electronic Mechanical Systems	L-T-P 3-0-0	3 Credits

Module-I: **(12 hours)**

Introduction and Emergence of MEMS, Scaling issues, materials for MEMS, Thin film deposition, Photolithography, doping, wet and dry etching

Micromachining Techniques: Surface and Bulk micro machining, wafer bonding, surface micro machining and LIGA process, Silicon as material for micromachining, (Chapter 3 and Section 8.2 of Book 1, Chapter 2 of Book 2)

Module-II: **(12 hours)**

MEMS devices, Engineering Mechanics for Micro System Modeling and Design – static bending of thin plates, Mechanical vibrational analysis, Thermo mechanical analysis, fracture mechanics analysis, thin film mechanics, Mechanics of deformable bodies, Energy method, Estimation of stiffness and damping for different micro-structures, Modeling of electromechanical systems, Pull-in voltage, Theory and design: Micro Pressure Sensor, micro accelerometer – capacitive and piezoresistive, micro actuator.(Section 4.1 to 4.3 and 6.2.2 of Book 1, Section 3.4 of Book 2)

Module-III: **(12 hours)**

MEMS Applications: Mechanical sensors and actuators: Piezoresistive pressure sensors, MEMS capacitive accelerometer, Optical Gyroscopes: Micro-lens, Micro-mirror, Optical Switch Radiofrequency MEMS: Inductor, Varactor, Filter, Resonator.

Microfluidics: Capillary action, Micro pumping, Electro wetting, Lab-on-a-chip.

Electronic interfaces, design, simulation and layout of MEMS devices using CAD tools. (Section 10.1to 10.8 of Book 2)

Books:

[1] G.K. Ananthsuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat and V.K. Atre: Micro and Smart Systems, Wiley India, New Delhi, 2010.

[2] N.P. Mahalik: MEMS, Tata McGraw-Hill, New Delhi, 2007.

[3] T. Hsu: MEMS and Microsystems: Design and Manufacture, Tata McGraw-Hill, New Delhi, 2002.

[4] Gabriel M. Rebeiz: RF MEMS Theory, design &Technology, Wiley India Education,2010.

Digital Learning Resources:

Course Name: MEMS and Microsystems
Course Link: https://nptel.ac.in/courses/117/105/117105082/
Course Instructor: Prof. Santiram Kal, IIT Kharagpur

6th Semester		Biomedical Instrumentation	L-T-P 3-0-0	3 Credits

Module-I: **(13 Hours)**

Introduction to Bioengineering, Biochemical Engineering, Biomedical Engineering, Sources of Biomedical Signals, Basic medical Instrumentation systems and their need, use of microprocessors in medical instruments, PC based medical Instruments, general constraints in design of medical Instrumentation system & Regulation of Medical devices.

Bioelectrical Signals & Electrodes: Origin of Bioelectric Signals, Electrocardiogram, Electroencephalogram, Electromyogram, Electrode-Tissue Interface, Polarization, Skin Contact Impedance, Motion Artifacts.

Module-II: **(10 Hours)**

Electrodes for ECG: Limb Electrode, Floating Electrodes, Pre-gelled disposable Electrodes, Electrodes for EEG, Electrodes for EMG.

Physiological Transducers: Introduction to Transducers, Classification of Transducers, Performance characteristics of Transducers, Displacement, Position and flow and pressure Transducers.

Strain gauge pressure transducers, Thermocouples, Electrical Resistance Thermometer, The mister, Photovoltaic transducers, Photo emissive Cells & Biosensors (Biochemical sensors).

Module-III: **(10 Hours)**

Recording Systems: Basic Recording systems, General considerations for Signal conditioners, Preamplifiers, Differential Amplifier, Isolation Amplifier, Electrostatic and Electromagnetic Coupling to AC Signals, Proper Grounding (Common Impedance Coupling)

Books:

[1] Hand Book of Biomedical Instrumentation by R.S. Khandpur,-2nd Edition, Tata McGrawHill, 2003.
[2] Introduction to Biomedical Engineering by Michael M.Domach,Pearson Education Inc,-2004.
[3] Biomedical Instrumentation and Measurements- by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, 2ndEdition, PHI learning Pvt. Ltd
[4] Introduction to Biomedical equipment technology,4e. By JOSEPH.J.CAAR &JOHN M.BROWN (Pearson education publication).
[5] Medical Instrumentation-application & design. 3e – By JOHN.G.WEBSTER John Wiley & Sons publications.

Digital Learning Resources:

Course Name: Biomedical Signal Processing
Course Link: https://nptel.ac.in/courses/108/105/108105101/
Course Instructor: Prof. Sudipta Mukhopadhyay , IIT Kharagpur

6th Semester		Artificial Intelligence and Machine Learning	L-T-P 3-0-0	3 Credits

Module-I: **(12 hours)**

INTRODUCTION –The Foundations of Artificial Intelligence; - INTELLIGENT AGENTS – Agents and Environments, Good Behaviour: The Concept of Rationality, the Nature of Environments, the Structure of Agents, SOLVING PROBLEMS BY SEARCH – Problem-Solving Agents, Formulating problems, Searching for Solutions, Uninformed Search Strategies, Breadth-first search, Depth-first search, Searching with Partial Information, Informed (Heuristic) Search Strategies, Greedy best-first search, A* Search, CSP, Means-End-Analysis.

Module-II: **(12 hours)**

ADVERSARIAL SEARCH – Games, The Mini-Max algorithm, optimal decisions in multiplayer games, Alpha-Beta Pruning, Evaluation functions, Cutting off search, LOGICAL AGENTS – Knowledge-Based agents, Logic, Propositional Logic, Reasoning Patterns in Propositional Logic, Resolution, Forward and Backward chaining - FIRST ORDER LOGIC – Syntax and Semantics of First-Order Logic, Using First-Order Logic , Knowledge Engineering in First-Order Logic - INFERENCE IN FIRST ORDER LOGIC – Propositional vs. First-Order Inference, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution

Module-III: **(6 hours)**

UNCERTAINTY – Acting under Uncertainty, Basic Probability Notation, The Axioms of Probability, Inference Using Full Joint Distributions, Independence, Bayes' Rule and its Use, PROBABILISTIC REASONING – Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distribution, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks

Module-IV: **(10 hours)**

LEARNING METHODS – Statistical Learning, Learning with Complete Data, Learning with Hidden Variables, Rote Learning, Learning by Taking Advice, Learning in Problem-solving, learning from Examples: Induction, Explanation-based Learning, Discovery, Analogy, Formal Learning Theory, Neural Net Learning and Genetic Learning. Expert Systems: Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition.

Books:

[1] Elaine Rich, Kevin Knight, & Shivashankar B Nair, Artificial Intelligence, McGraw Hill,3rd ed.,2009

[2] Stuart Russell, Peter Norvig, *Artificial Intelligence -A Modern Approach*, 2/e, Pearson, 2003.

[3] Nils J Nilsson, *Artificial Intelligence: A New Synthesis*, Morgan Kaufmann Publications,2000

[4] Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI.,2010

[5] S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed.2011

Digital Learning Resources:

Course Name:	Artificial Intelligence Search Methods For Problem Solving
Course Link:	https://swayam.gov.in/nd1_noc20_cs81/preview
Course Instructor:	Prof. D. Khemani, IIT Madras

	Fundamentals of Artificial Intelligence
Course Name:	
Course Link:	https://swayam.gov.in/nd1_noc20_me88/preview
Course Instructor:	Prof. S. M. Hazarika, IIT Guwahati
Course Name:	Introduction to Machine Learning
Course Link:	https://nptel.ac.in/courses/106/105/106105152
Course Instructor:	Prof. S. Sarkar, IIT Kharagpur
Course Name:	Machine Learning
Course Link:	https://nptel.ac.in/courses/106/106/106106202
Course Instructor:	Prof. Carl Gustaf Jansson, IIT Madras

6th Semester		Renewable Power Generation Systems	L-T-P 3-0-0	3 Credits

Module I: **(15 Hours)**

Introduction: Conventional energy Sources and its Impacts, Non-conventional energy– seasonal variations and availability, Renewable energy – sources and features, Distributed energy systems and dispersed generation (DG). Solar Energy: Solar processes and spectral composition of solar radiation. Solar Thermal system-Solar collectors, Types and performance characteristics, Applications-Solar water heating systems (active & passive), Solar space heating & cooling systems, Solar desalination systems, Solar cooker. Solar photovoltaic system-Operating principle, Photovoltaic cell concepts, Cell, module, array, Losses in Solar Cell, Effects of Shadowing-Partial and Complete Shadowing, Series and parallel connections, Cell mismatching, Maximum power point tracking, Applications-Battery charging, Pumping, Lighting, Peltier cooling. Modelling of PV cell.

Module II: **(10 Hours)**

Wind Energy: Wind energy, Wind energy conversion; Wind power density, efficiency limit for wind energy conversion, types of converters, aerodynamics of wind rotors, power ~ speed and torque speed characteristics of wind turbines, wind turbine control systems; conversion to electrical power: induction and synchronous generators, grid connected and self excited induction generator operation, constant voltage and constant frequency generation with power electronic control single and double output systems, reactive power compensation, Characteristics of wind powerplant, Concept of DFIG.

Module III: **(9 Hours)**

Biomass Power: Principles of biomass conversion, Combustion and fermentation, Anaerobic digestion, Types of biogas digester, Wood gassifier, Pyrolysis, Applications. Bio gas, Wood stoves,Bio diesel, Combustion engine, Application.

Module IV: **(6 Hours)**

Hybrid Systems: Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles.

Books:

[1] Godfrey Boyle "Renewable Energy- Power for a Sustainable Future",Oxford University Press.
[2] B.H.Khan, "Non-Conventional Energy Resources", Tata McGraw Hill, 2009.
[3] S. N. Bhadra, D. Kastha, S. Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.
[4] S. A. Abbasi, N. Abbasi, "Renewable Energy Sources and Their Environmental Impact", Prentice Hall of India, New Delhi, 2006.

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Digital Learning Resources:

Course Name: Energy Resources and Technology
Course Link: https://nptel.ac.in/courses/108/105/108105058/
Course Instructor: Prof. S Banerjee, IIT Kharagpur

6th Semester		Data Communication and Computer Networks	L-T-P 3-0-0	3 Credits

Module – I (10 Hrs)

Overview of Data Communication Networks, Protocols and standards, OSI Reference model, TCP/IP Protocol. Physical Layer: Analog Signals, Digital Signals, Data Rate Limits, Transmission Impairment, Data rate limit, Digital Transmission: Digital-to-Digital conversion, Analog-to-Digital conversion, Transmission modes, Analog Transmission: Digital-to-Analog conversion, Analog-to-Analog conversion, Multiplexing: Frequency Division Multiplexing (FDM), Wave Division Multiplexing (WDM), Time Division Multiplexing (TDM), Transmission Media: Guided Media (Twisted-Pair Cable, Coaxial Cable and Fiber-Optic Cable) and unguided media (wireless), Switching: Circuit Switched Network, Datagram Network, Virtual-Circuit Network , Telephone Network, Dial-up Modems and Digital Subscriber Lines.

Module – II (09 Hrs)

Error Detection and correction: Types of Errors, Error Detection mechanism (Linear codes, CRC, Checksum), Error Correction mechanism: Hamming Encoding. Data Link Control and Protocols: Flow and Error Control, Stop-and-Wait ARQ. Go-Back-N ARQ, Selective Repeat ARQ, HDLC and Point-to-Point Protocol Multiple Access: Random Access (ALOHA, CSMA, CSMA/CD, CSMA/CA), Controlled Access (Polling, Reservation, Token Passing), Channelization (FDMA, TDMA, CDMA). Wired LANs (Ethernet): Traditional Ethernet, Fast Ethernet, Gigabit Ethernet.

Module – III (09 Hrs)

Wireless LANs: IEEE 802.11 and Bluetooth. Connecting Devices: Passive Hub, Repeater, Active Hub, Bridge, Two layers Switch, Router, Three layers Switch, Gateway. Virtual Circuit Networks: Frame Relay, Architecture & layers, ATM: Design goals, Architecture & layers. Network Layer: IPV4 addresses, IPV6 addresses, Internet Protocol: Internetworking, IPV4 datagram, IPV6 packet format and advantages. Network Layer Protocols: ARP, RARP, IGMP and ICMP. Routing: Unicast Routing Protocols and Multicast Routing Protocols. Transport Layer: Process to Process Delivery, User Datagram Protocol (UDP) and Transmission Control Protocol (TCP).

Module – IV (08Hrs)

Domain Name System (DNS): Name Space, Domain Name Space, DNS in Internet, Resolution and Dynamic Domain Name System (DDNS), Remote logging, Electronic Mail (SMTP) and file transfer (FTP), WWW: Architecture & Web document, HTTP: Transaction & Persistent vs. Non-persistent connection. Introduction to Wi-Fi and Li-Fi Technology.

Books:

1. Data Communications and Networking, Behrouz A. Forouzan, Tata McGraw-Hill.

2. Computer Networks, A. S. Tannenbum, D. Wetherall, Prentice Hall, Imprint of Pearson.

3. Computer Networks A system Approach, Larry L, Peterson and Bruce S. Davie, Elsevier.

4. Computer Networks, Natalia Olifer, Victor Olifer, Willey India.

5. Data and Computer Communications, William Stallings, Prentice Hall, Imprint of Pearson.

Digital Learning Resources:

Course Name:	Data Communication
Course Link:	https://nptel.ac.in/courses/106/105/106105082/
Course Instructor:	Prof. A. Pal , IIT Kharagpur

Course Name:	Computer Networks
Course Link:	https://nptel.ac.in/courses/106/105/106105080/
Course Instructor:	Prof. A. Pal , IIT Kharagpur

6th Semester	RIK6F001	Essence of Indian Knowledge Tradition-1	L-T-P 3-0-0	0 Credits

Course Objective:

The course aims at imparting basic principles of thought process, reasoning and inferencing. Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature. Holistic life style of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. The course focuses on introduction to Indian Knowledge System, Indian perspective of modern scientific world-view and basic principles of Yoga and holistic health care system.

Course Outcomes:

- Ability to understand, connect up and explain basics of Indian Traditional knowledge modern scientific perspective.

Course Content:

- Basic Structure of Indian Knowledge System (i) वेद, (ii) उपवेद (आयुर्वेद, धनुर्वेद, गान्धर्वेद, स्थापत्य आदि) (iii) वेदांग (शिक्षा, कल्प, निरुत, व्याकरण, ज्योतिष छंद), (iv) उपाङ्ग (धर्म शास्त्र, मीमांसा, पुराण, तर्कशास्त्र)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case Studies.

Books:

1. V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014

2. Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan

3. Fritzof Capra, Tao of Physics

4. Fritzof Capra, The wave of Life

5. V N Jha (Eng. Trans,), Tarkasangraha of Annam Bhatta, Inernational Chinmay Foundation, Velliarnad, Amaku,am

6. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta

7. GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, Vidyanidhi Prakasham, Delhi, 2016

8. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakasham, Delhi, 2016 9. P R Sharma (English translation), Shodashang Hridayam

6th Semester	RCS6C201	Microwave Engineering Lab	L-T-P 0-0-3	2 Credits

(Any Ten of the following experiments are to be performed with X-band/S-band/ Ku- band Microwave components.}

1. Reflex Klystron Characteristics
2. Gun Diode Characteristics
3. Directional Coupler Characteristics
4. Measurement of Voltage Standing Wave Ratio.
5. Radiation Pattern Measurement of a Horn Antenna
6. Impedance, Wavelength and Frequency Measurement.
7. Determination of Polarization of Horn antenna.
8. Measurement of Scattering Parameters.
9. Coupling Measurement of H-plane, E-Plane and Magic Tee junctions.
10. Measurement of Dielectric Constant.
11. Measurement of Phase shift.
12. Scattering parameters of Circulator /Isolators.

Digital Learning Resources:

Virtual Lab Link:

6th Semester	RCS6C202	Wireless Communication Lab	L-T-P 0-0-3	2 Credits

List of Experiments

1. Evaluate the impact of path loss and shadowing in estimation of received signal power in mobile cellular communication using fading channel mobile communication virtual lab.

2. Calculate the boundary coverage probability in a cellular system using fading channel mobile communication virtual lab.

3. Demonstrate the impact the received power levels for hand-off in case of mobile cellular communication using fading channel mobile communication virtual lab.

4. Estimate the impact of sectoring in increasing cellular system capacity using fading channel mobile communication virtual lab.

5. Examine the impact of co-channel interference on the value of SIR in mobile cellular communication using fading channel mobile communication virtual lab.

6. Setting up of LTE 2x2 MIMO system for establishing two way communication.

7.Study of pure ALOHA and slotted ALOHA protocols for WLAN System.

8. Configure ZigBee module as an end device and, set up a communication link with two ZigBee modules.

9. Study of RFID system and its applications.

10. Using IE3D, design a rectangular micro strip patch antenna for inset feed for operating frequency of 1.88 GHz, relative permittivity of 4.4 and length of 31 mils.

11. Using GPS system, study the graphical representation of geographical position using Survey plotting.

12. Study the PN sequence and examine Gold code with variable sequence length and analyze its correlation. Also set up voice communication using DSSS scheme using CDMA trainer kit (ST-2131-A).

Optional Experiments

1. Study the GPRS system and use it for sending an e-mail through WI-GPRS trainer.

2. Study the GSM modem and its different module for phone book, setting up a call, sending SMS and identifying call history using AT commands.

3. Interfacing of GSM modem with control unit.

4. Design a patch antenna using IE3D using different parameters.

Digital Learning Resources:

Virtual Lab Link: http://vlabs.iitb.ac.in/vlabs-dev/labs/dblab/index.php

6th Semester		**Future-ready Contributor Program**	**L-T-P 0-0-3**	**2 Credits**

Outcomes: The Future-ready Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them recognize how they as technical professionals, can participate and make a positive contribution to their communities and to their state.

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Odisha.

The Contributor Program syllabus has been evolved and fine-tuned over several years, to –

a) address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire;
b) working extensively with universities and students and an appreciation of their challenges and concerns;
c) guided by the higher ideas and principles of practical Vedanta in work.

Sr. No.		Content	Total Hrs
1	**Part 1 : Developing self-efficacy and basic inner strength**	**Who is a Future-ready Contributor?** *In this topic, students understand the new work environment, expectations from future workforce, and importance of being a future-ready contributor. This enables students to transform their expectation of themselves in work*	3 hrs lab sessions (discovery-based facilitator led)
2		**Self-esteem & Growth Identity** *In this topic, students learn how to develop a deeper and more resilient self esteem and how to adopt a growth identity/ mindset, that is more appropriate to the demands of the future workplace.*	Same as above
3		**Become a Creator of one's destiny** *In a "victim stance", we see the career environment as full of difficulties and hurdles. We feel powerless or blame our circumstances for not having many opportunities. This makes us fearful of uncertainty and makes us settle for jobs where we remain mediocre. In this topic, students discover the "creator of destiny stance" to challenges and situations. This stance helps them take ownership & responsibility to shape destiny, build a new future & find answers to challenges; and stop being complainers.*	Same as above
4	**Part 2 : Building ability to make more effective career choices**	**Achieving Sustainable Success** *In this topic, students discover how to achieve sustainable or lasting success, by making themselves success-worthy. Where their focus shifts to building one's "engine of success" rather than being on chasing the "fruits of success". This is important, because over a lifetime of work, all people go through ups and downs – where the fruits are not in their control. People who are focused on the fruits of success, fall prey to disappointment, loss in motivation, quitting too early, trying to find shortcuts – when fruits don't come. Whereas people focused on building their engine of success continue to contribute steadily, irrespective of whether fruits come or not. This helps them make better choices in life, that leads to steady success & long-term career fulfillment in an uncertain world.*	Same as above
5		**Career Development Pathways for a changing world**	Same as above

		In this topic, students explore a range of diverse "career development models" and the possibilities for contribution each opens up to them. This helps them open up hidden opportunities that such an environment offers. And free themselves from a herd mentality when making career choices.	
6		**Make an impact in every part of one's life** *In this topic, students learn how to expand the contribution possible in any role they have. This helps them take charge of own career growth & discover their power to contribute in any role or job.*	Same as above
7	**Part 3 : Building ability to become solution and value creating individuals in the world**	**Think Solutions** *The market environment in which organizations are operating, is becoming increasingly dynamic and uncertain. So, employers are increasingly seeking out people who can innovate and figure out solutions in the face of any challenge (unlike in the past when it was the people who were most efficient and productive, who were valued by organizations). At the heart of innovation lies this way of thinking of "finding solutions" rather than "seeing problems or roadblocks". Students learn how to build this way of thinking, in this topic.*	Same as above
8		**Value Thinking** *Companies are also looking for employees who do not just work hard, or work efficiently or productively - but those who will make a valuable difference to the fortunes of the company. This difference may come from innovation, but it may also come from focusing on the right things and identifying what really matters – both to the company and to the customers. In this topic, students learn how to build this capability.*	Same as above
9		**Engaging Deeply** *The environment we live in is becoming increasingly complex because more and more things are getting interconnected, new fields are emerging, technologies are rapidly changing, capabilities and knowledge one is trained in will become fast obsolete. In such a scenario, the student's ability to quickly understand and master what is going on, dive deep, get involved in any area, rapidly learn new capabilities that a job demands, is*	Same as above

		important. In this topic, students learn how to engage deeply. Learning how to dive deep, to quickly understand what is going on, get involved in any area, and rapidly learn.	
10	**Part 4 : Building ability to work collaboratively and as good citizens of organizations and the country**	**Enlightened self-interest & collaboration at work** *The changing nature of work in organizations and in the global environment, is increasingly demanding that people work more collaboratively towards shared goals and more sustainable goals. A key to working successfully when multiple stakeholders are involved, is "thinking in enlightened self-interest". In this topic, students learn how to widen their thinking from "narrow self-interest" to "enlightened self-interest" to work more effectively in teams & collaboratives.*	Same as above
11		**Human-centered thinking & Empathy** *In this topic, students learn to recognize & respond to human needs and challenges – the way of thinking at the heart of user-centric designs & customer-centricity.*	Same as above
12		**Trust Conduct** *The biggest currency in a sustainable career is "trust" i.e. being trusted by team members, bosses, customers. When we are trusted, people listen to us, they are willing to give us the chance to grow, give us the space to make mistakes, and work seamlessly with each other without always having to "prove ourselves". In this topic, students learn how to build trust with people they engage with.*	Same as above
Contribution Project Lab Sessions		*3 Contribution projects that help them apply contributor thinking. After students complete their project work (beyond the classroom), each project ends with this 3 hr lab session where they build their project output and present.*	9 hrs (3 hr lab sessions for each of 3 projects)
Project work		*The above Contribution Projects require research, and may need field work beyond the classroom that students are expected to do.*	Beyond classroom

Lab Sessions:

- Students will have to attend twelve discovery-based lab sessions to build new models of thinking & capacities (3 hrs per module)
- They will work closely with their peers to discuss and understand these new models of thinking.
- Their learning will be facilitated by trained college faculty.

Contribution Projects

- Three contribution projects that help them apply contributor thinking
- These will require research and also may need field work
- Each ends with a 3 hr lab session where they build their project output and present