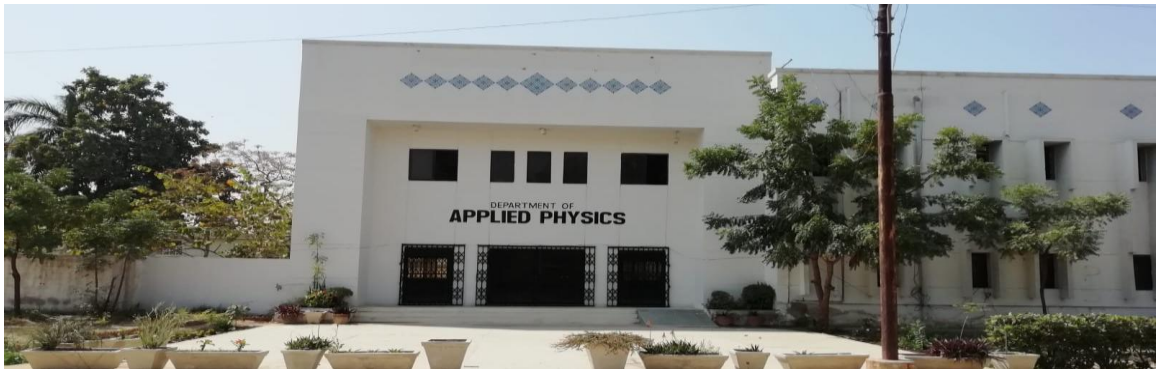
Curriculum

B. S.

Applied Physics

2024

Department of Applied Physics



MISSION STATEMENT

The mission of the department of Applied Physics at University of Karachi is to provide profound education in applied physical sciences which can be utilized in various fields of science & technology. The fundamental approach of the department is to develop professional and technical skills in the students and is dedicated to educating future generations of research and development professionals, data specialist, technology experts, innovators and scientists for industry & society.

OBJECTIVES

The graduates of the department of Applied Physics, University of Karachi will be able:

1. To contribute to advanced technology projects.
2. To utilize the technical skills with analytical approach to conduct research.
3. To pursue career in R&D organization as JSO/SO/PSO; in various industries as technical officers/HoD instrumentation & control; in system designing and maintenance industry as system analyst, DM/Managers/GM; and in HEIs as Lecturer/Assistant Professor/Associate Professor/Professor.

FRAMEWORK OF STUDY

Degree Title:	B.S. Applied Physics
Total Credit Hours:	143 Credit Hours (CH) (General Education: 30 CH; Interdisciplinary: 24 CH; Compulsory: 8 CH; Major 81 CH)
Degree Qualifying CGPA:	2.2 / 4.0
Passing Percentage:	50%
Duration:	4 Years
Semesters:	8

- Course numbers, titles and contents of the *General Education* courses will be offered as per the University policy.
- Interdisciplinary courses will be opted from allied department such as Mathematic.
- Internship may be completed during the semester break.

Course Structure - B.S. (Applied Physics)

Year I: Semester – I

S. #	Course Title	Course No.	Credit Hours	Course Type
1.	Urdu or Sindhi or Humanities	300.1 (U)	2 + 0	General Education
2.	Islamic Studies or Ethics (For Non-Muslim)	300.1 (IS)	2 + 0	General Education
3.	Civics and Community Engagement	300.1(Civ/Com)	2 + 0	General Education
4.	Natural Science	300.1 (N.Sc)	3 + 0	General Education
5.	Mathematics I	301	3 + 0	Interdisciplinary
6.	Introduction to Computer & Programming Languages	Appl. Phys. 303	2 + 1	Interdisciplinary
7.	Mechanics (Physics I)	Appl. Phys. 305	2 + 1	Major
				18 Credit Hours

Year I: Semester – II

S. #	Course Title	Course No.	Credit Hours	Course Type
1.	Ideology & Constitution of Pakistan	300.2 (IC)	2 + 0	General Education
2.	Pakistan Studies	300.2 (PSt.)	2 + 0	Compulsory
3.	Entrepreneurship	300.2 (Entr)	2 + 0	General Education
4.	Functional English	300.2 (Eng)	3 + 0	General Education
5.	Introduction to Social Science	300.2 (Soc.Sc)	2 + 0	General Education
6.	Mathematics II	302	3 + 0	Interdisciplinary
7.	Data Structure & Algorithm	Appl. Phys. 304	2 + 1	Interdisciplinary
8.	Electricity & Magnetism (Physics II)	Appl. Phys. 306	2 + 1	Major
				20 Credit Hours

Year II: Semester – III

S. #	Course Title	Course No.	Credit Hours	Course Type
1.	Quantitative Reasoning I	400.1 (Q. Reas)	3 + 0	General Education
2.	Expository Writing	400.1 (E. Writ)	3 + 0	General Education
3.	Mathematics III	401	3 + 0	Interdisciplinary
4.	Computational Methods	Appl. Phys. 403	2 + 1	Interdisciplinary
5.	Circuit Theory	Appl. Phys. 405	2 + 1	Major
6.	Quantum Mechanics	Appl. Phys. 407	3 + 0	Major
				18 Credit Hours

Year II: Semester – IV

S. #	Course Title	Course No.	Credit Hours	Course Type
1.	Quantitative Reasoning II	400.2 (Q. Reas)	3 + 0	General Education
2.	Application of Information & Communication Technologies	400.2 (ICT)	3 + 0	General Education
3.	Mathematics IV	402	3 + 0	Interdisciplinary
4.	Introduction to Computer Networks	Appl. Phys. 404	2 + 1	Interdisciplinary
5.	Basic Electronic	Appl. Phys. 406	2 + 1	Major
6.	Introduction to Renewable Energy	Appl. Phys. 408	3 + 0	Major
				18 Credit Hours

Year III: Semester – V

S. #	Course Title	Course No.	Credit Hours	Course Type
1.	Linear Integrated Circuits	Appl. Phys. 501	3 + 0	Major
2.	Laser and Applied Optics	Appl. Phys. 503	3 + 0	Major
3.	Power Electronics	Appl. Phys. 505	3 + 0	Major
4.	Solid State Physics	Appl. Phys. 507	3 + 0	Major
5.	Digital Electronics	Appl. Phys. 509	2 + 1	Major
6.	Experimental Electronics I	Appl. Phys. 511	0 + 3	Major
				18 Credit Hours

Year III: Semester – VI

S. #	Course Title	Course No.	Credit Hours	Course Type
1.	Communication Electronics	Appl. Phys. 502	3 + 0	Major
2.	Semiconductor Devices	Appl. Phys. 504	3 + 0	Major
3.	Digital Logic Design	Appl. Phys. 506	1 + 2	Major
4.	Industrial Electronics & Automation	Appl. Phys. 508	3 + 0	Major
5.	Signal and Systems	Appl. Phys. 510	3 + 0	Major
6.	Experimental Electronics II	Appl. Phys. 512	0 + 3	Major
				18 Credit Hours

Year IV: Semester – VII

S. #	Course Title	Course No.	Credit Hours	Course Type
1.	Microprocessor Architecture & Programming	Appl. Phys. 601	2 + 1	Major
2.	Microwave Communication	Appl. Phys. 603	2 + 1	Major
3.	Elective I	Appl. Phys. 61x	3 + 0	Major
4.	Elective II / Thesis I	Appl. Phys. 62x	3 + 0	Major
5.	Internship	600.1	0 + 3	Compulsory
				15 Credit Hours

Year IV: Semester –VIII

S. #	Course Title	Course No.	Credit Hours	Course Type
1.	Digital Signal Processing	Appl. Phys. 602	2 + 1	Major
2.	Microprocessor Interfacing	Appl. Phys. 604	1 + 2	Major
3.	Control Systems	Appl. Phys. 606	3 + 0	Major
4.	Elective III	Appl. Phys. 61x	3 + 0	Major
5.	Elective IV / Thesis II	Appl. Phys. 62x	3 + 0	Major
6.	Capstone Project	600.2	0 + 3	Compulsory
				18 Credit Hours

Total Credit Hours **143**

Elective-I

S. #	Course Title	Course No.	Credit Hours
1.	Introduction to Nanotechnology	Appl. Phys. 611	3 + 0
2.	Embedded System	Appl. Phys. 613	2 + 1
3.	Data Communication & Networking	Appl. Phys. 615	3 + 0
4.	Wind and Solar Energy	Appl. Phys. 617	3 + 0

Elective-II

S. #	Course Title	Course No.	Credit Hours
1.	Nanoelectronic Devices	Appl. Phys. 621	3 + 0
2.	Internet-of-Things (IoT)	Appl. Phys. 623	2 + 1
3.	Broadband Communication	Appl. Phys. 625	3 + 0
4.	Biofuels and Biomass Energy	Appl. Phys. 627	3 + 0
5.	Thesis I	Appl. Phys. 629	0 + 3

Elective-III

S. #	Course Title	Course No.	Credit Hours
1.	Electronic Transport at Nanoscale	Appl. Phys. 612	3 + 0
2.	Instrumentation	Appl. Phys. 614	3 + 0
3.	Optical Communication	Appl. Phys. 616	2 + 1
4.	Tidal and Hydro Energy	Appl. Phys. 618	3 + 0

Elective-IV

S. #	Course Title	Course No.	Credit Hours
1.	Functional Materials	Appl. Phys. 620	3 + 0
2.	Artificial Intelligence & Machine Learning	Appl. Phys. 622	3 + 0
3.	Wireless Communications	Appl. Phys. 624	3 + 0
4.	Smart Grid Technology	Appl. Phys. 626	3 + 0
5.	Thesis II	Appl. Phys. 628	0 + 3

Course Outlines - B.S. (Applied Physics)

Introduction to Computer & Programming Languages -- Appl. Phys. 303 -- 2 + 1 CH

Course Objective:

This course aims to provide fundamental concepts of programming with the use of an IDE. Additionally, this course intends to familiarize students with the Computer Operating Systems and their User Interfaces.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Understand structure and functionalities of a Computer Operating System,
- Apply fundamental programming concepts,
- Develop and execute algorithms using an IDE.

Course Outline:

Introduction to Operating Systems: DOS and other Operating Systems and their User Interface. Basic commands and their execution.

Introduction to Programming Languages: Introduction to various programming languages, Understanding the C Integrated development environment (IDE) as the C programming environment, Building blocks of C language, Algorithms and Flowcharting, File systems in C language.

Programming In C Language: Standard Functions, Data Types and Format Specifiers, Loops and their structure, Nested loops, Decisions, Functions, Array and strings, Operators, Pointers and Pointer Variables, C graphics functions.

Introduction to Object Oriented Programming: Introduction to C++programming language, Objected oriented programming.

List of Experiments:

1. Printing numbers and characters using C standard functions printf(), scan().
2. Understanding Format Specifiers. Learnig data types, Variables and address operator.
3. Learning Loops styling. Write the C program to generate the ASCII code using for loop. Write the C program to print the multiplication table using nested for loop. Write C program to compute the factorial of given number using for loop, while loop and do while loop.
4. Write C code for four-functions Calculators using else if conditions and switch statements.
5. Learning functions that return a value. Write C code to draw bar graph showing the results in percentage by passing variables as argument to functions.
6. Understanding arrays of many dimensions. Write C program to input the student names and their scores as input and print the results in ascending and descending order.
7. Understanding Indirection Operators, Pointers and pointer variables. Test functions that add constant to two values. Understanding Pointers and Arrays.
8. Write C program that averages the temperature values using pointer variables. Write C program that demonstrate multiple structure variable of the same type.
9. Write C program that demonstrate assignment of structure and passing structures to functions.
10. Write C program that demonstrates the reading of one character at a time from a file and reading of formatted data from a file. Write C program that writes sentences typed at keyboard to a file.

Books Recommended:

1. K N King. 2023. C Programming: A Modern Approach. 3rd Edition. W. W. Norton & Company.
2. Yashavant Kanetkar. 2022. Let Us C: Authentic guide to C programming language. 19th Edition. BPB Publications.
3. Joakim Wassberg. 2020. Computer Programming for Absolute Beginners. 1st Edition. Packet Publishing.
4. Josh Lospinoso, 2019, C++ Crash Course, 1st Edition, No Starch Press Inc.
5. Peter Prinz, Tony Crawford. 2015. C in a Nutshell: The Definitive Reference. 2nd Edition. O'Reilly Media.

Data Structures & Algorithms -- Appl. Phys. 304 -- 2 + 1 CH

Course Objective:

This course aims to develop understanding of fundamental concepts of algorithms and data structures.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Design and implement efficient algorithms for various problems.
- Choose appropriate data structures for different problem scenarios.
- Solve algorithmic problems using techniques like recursion, divide and conquer, and dynamic programming.

Course Outline:

Introduction to Java and C++ Programming: An Introduction to Java Programming, an introduction to C++ programming, how java differs from C and C++. Integrated Development Environment (IDE) for JAVA and C++. The JAVA Platform. Object Oriented Programming (OOP): Overview of Object Oriented Programming, Analysis of Algorithm, sorting algorithms, graphs, Inheritance, Single and Multiple inheritance, Interfaces and Packages.
Data Structures: Data types, arrays, strings, structures, classes, stacks, queues and linked lists. Sequences, Trees, Priority queues. Sorting (Bubble sort, Insertion sort, Selection sort, Merge sort, Quick sort, Heap sort)
Mathematical Programing: Introduction of mathematical programming: MatLab, Mathemitica, & Mapal.

List of Experiments:

1. Objects and Classes.
2. Creating a class hierarchy.
3. Creating a Subclass.
4. Statements and Expressions.
5. Data types. Literals.
6. Expressions and Operators.
7. Working with objects.
8. Calling Methods.
9. The Class Library.
10. Arrays, Conditions and Loops.
11. Creating Class and Applications in the selected programming language. Programming Applications and Command Line arguments.
12. Optional: Java Applets basics. Creating Applets. Including an Applet on a Web page.

*To carry out the experimental course either of JAVA or C++ programming language may be used.

Books Recommended:

1. H. Cormen, Charles E. Leiserson. 2022, Introduction to Algorithms, 4th Ed., The MIT Press.
2. Sartaj Sahni, 2004, Data Structures, Algorithms, and Applications In C++, 2nd Ed., Silicon Press.
3. Ivor Horton, 2002, Beginning Java, 2nd Edition, Wrox Press, Arden House, USA.
4. Florian Hawlitzek, 2002, Java 2 Nitty Gritty, 1st Edition, Addison Wesley, Germany.
5. John Lewis and William Loftus, 2001, Java Software Solutions, 1st Edition, Addison Wesley, USA.

Mechanics (Physics I) -- Appl. Phys. 305 -- 2 + 1 CH

Course Objective:

This course aims to develop a strong foundation in the principles of classical mechanics using Vector Analysis and mathematical tools necessary for solving physics problems.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Apply the concepts of Classical Mechanics to understand and analyze real-world situations.
- Develop critical thinking and problem-solving skills.
- Gain experience in conducting experiments and analyzing data.

Course Outline:

Introduction to Mechanics: Units, dimensions, and significant figures, Vectors and scalars, Kinematics (motion in one and two dimensions), Newton's laws of motion, Work, energy and power.

Dynamics of Particles and Systems: Forces in nature (gravity, friction, etc.), System of Particles, Conservation of momentum, Impulse and collisions, Rotational motion (torque, angular momentum, rotational kinetic energy).

Oscillations and Waves: Simple harmonic motion (SHM), Damped and Forced Oscillations, Wave motion (types of waves, wave equation, superposition principle), Sound waves and Doppler's effect.

Thermodynamics: Kinetic Molecular Theory and the Ideal Gas Law, Statistical Mechanics, Temperature, Heat and Zeroth Law of Thermodynamics, First Law of Thermodynamics, Entropy and the Second Law of Thermodynamic. Heat engines and refrigerators.

Bulk properties of matter: Elasticity, Tension, Compression, Elastic modulus, Poisson's ratio, Viscosity.

List of Experiments:

1. Linear Physical Measurements and Systematic Error Analysis using High Precision Measuring Instruments
2. Determination of Resultant Vector by Equilibrium of Three Forces method.
3. Study of Static Equilibrium using Lever Principle. Determination of Resultant Force by using Inclined Plane.
4. Study of Projectile and other Two-Dimensional Motions.
5. Study of Static and Kinetic Force of Friction using Inclined Plane. Study of Collisions in 1-Dimension and 2-Dimensions.
6. Determination of Spring Constant using Hooke's Law. Determination of value of "g" by using Simple Harmonic Oscillators.
7. Determination of Rotational Inertia by using Compound Pendulum.
8. Study of Kinetic Molecular Theory using Ideal Gas Chamber Model. Study of Thermodynamic Processes using Ideal Gas Chamber Model.
9. Surface tension of water by Jaeger's method. Coefficient of viscosity of oil by Stokes method.
10. Young's modulus of material by bending of beam method.

Books Recommended:

1. Hugh D. Young and Roger A. Freedman, 2023, University Physics with Modern Physics, 15th Edition, Pearson Education Inc.
2. Raymond A. Serway and John W. Jewett, 2018, Physics for Scientists and Engineers, 10th Edition, Cengage Learning.
3. David Halliday and R. Resnick, 2020, Principles of Physics, 11th Ed., Wiley.
4. David Halliday, R. Resnick and J. Walker, 2013, Fundamentals of Physics, 10th Ed., Wiley.
5. David Halliday, Robert Resnick & Kenneth S. Krane, 2001, Physics, Volume 1, 5th Ed., Wiley.

Electricity & Magnetism (Physics II) -- Appl. Phys. 306 -- 2 + 1 CH

Course Objective:

This course aims to develop a strong foundation in the principles and laws of Electrostatics, Electrodynamics, Magnetism and Optics for solving physics problems.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Understand the fundamental principles of electricity and magnetism.
- Apply mathematical tools to solve problems in electromagnetism.
- Analyze and interpret experimental data related to electric and magnetic phenomena.

Course Outline:

Electrostatics: Electricity & Magnetism: Electric charge and Coulomb's Law, the Electric Field, Gauss' Law, Electrical Potential, Capacitors and Dielectrics.

Electrodynamics: Current and Ohm's Law, Resistance and resistivity of materials, Resistive Circuits (series and parallel), RC circuits and their transients.

Magnetism of Matter and Electromagnetism: The magnetic Field, Ampere's Law, Faraday's Law of Induction, Magnetic Properties of Matter, Inductance, Alternating current Circuits (LC, RL, RC, RLC circuits), Maxwell's Equations, Electromagnetic waves.

Optics: The nature and Propagation of Light, Reflection and Refraction at Plane Surfaces, Spherical Mirrors and Lenses, Interference, Diffraction, Grating and Spectra, Polarization.

List of Experiments:

1. Determination of AC mains frequency by Vibrograph.
2. Measurement of resistance using Neon Flash bulb and condenser.
3. Measurement of High Resistance by Leakage method. Measurement of Low Resistance by Carey Foster Bridge.
4. Comparison of capacitance by Anderson's Bridge.
5. Verification of law of combination of resistance by potentiometer.
6. Study of RC transients with DC charging and discharging of capacitors.
7. Study of Back EMF using Inductive Voltage Divider Circuit.
8. Determination of Resonance Frequency by Acceptor circuit. Determination of Resonance Frequency by Rejecter Circuit.
9. Study of the Magnetic Forces on Conductors. Study of the Earth's Magnetic Field. Study of the Magnetic Fields of Coils.
10. Study of Lenz's Law using Pickup Coil. Study of Mutual Induction Principle using Transformer Coils.

Books Recommended:

1. Hugh D. Young and Roger A. Freedman, 2023, University Physics with Modern Physics, 15th Edition, Pearson Education Inc.
2. David Halliday and R. Resnick, 2020, Principles of Physics, 11th Ed., Wiley.
3. David Halliday, R. Resnick and J. Walker, 2013, Fundamentals of Physics, 10th Ed., Wiley.
4. Raymond A. Serway and John W. Jewett, 2018, Physics for Scientists and Engineers, 10th Edition, Cengage Learning.
5. David Halliday, Robert Resnick & Kenneth S. Krane, 2001, Physics, Volume 1, 5th Ed., Wiley.

Computational Methods - Appl. Phys. 403 - 2 + 1 CH

Course Objectives:

This course aims to understand the fundamental principles of numerical methods and implement numerical algorithms using programming languages like MATLAB, Python, or C++.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- To gain valuable computational skills that are essential for careers in science, engineering, and other quantitative fields.
- Apply numerical methods to solve real-world problems.
- Analyze the accuracy and efficiency of different numerical methods.

Course Outline:

Fundamentals of Numerical Computations: Fundamental numerical methods, Basic recursions and successive approximation, Floating Point Arithmetic, errors in numerical computation, Polynomial Approximation, Newton's Divided – Difference methods, forward differences, Survey of methods and software.

Numerical Methods for Root-Finding (Solutions of Equations in One Variable): Bisection method, Newton-Raphson method, Secant method, Fixed-point iteration and Error Analysis.

Numerical Methods for Linear Systems: Direct Methods for Solving Linear Systems of Equations, Linear Algebra and Matrices, The Determinant of a Matrix, Eigen values and Eigen Vectors. Gaussian elimination, LU decomposition, Gauss-Seidel method, Jacobi method.

Numerical Solutions of Nonlinear Systems of Equations: Solutions of nonlinear Algebraic Equations.

Numerical Integration: Trapezoidal rule, Simpson's rule, Romberg integration, Gaussian quadrature methods. Numerical Differentiation: Finite difference methods, Richardson extrapolation, Interpolation method.

Numerical Solution of Ordinary Differential Equations: Elementary theory of Initial Value Problems, Euler's method, Runge-Kutta methods, Predictor-Corrector methods.

Numerical Solution of Partial Differential Equations: Finite difference methods, Finite element methods.

Statistical Methods: Laws of Probability, Population Statistics, sample space, random variables, Transform techniques, Simple random Processes and their probability distribution, Elements of Statistical Inference, Data analysis.

Simulation & Modeling: Mathematical modeling of physical systems, Mathematical modeling and computer simulation of some physical systems such as free falling object, Oscillatory motion, Kepler's problem etc.

List of Experiments:

1. Introduction of Matlab environment & Introduction to Python.
2. Generate Geometric series, Arithmetic series and Fibonacci series of N terms and sum of the terms.
3. To find the value of ln(1+x), Sin(x) and Cos(x) using Taylor series.
4. To find the root of nonlinear equation by using Bisection method, Regula Falsi method, Secant method, Fixed Point method and Newton Raphson method.
5. Addition, Subtraction, Multiplication, Determinant and Inverse of the matrix.
6. Solve the linear equations by Gauss Elimination method.
7. Solve the equations by Gauss Jordon method, Gauss Siedal method and Jacobi method.
8. Interpolation using Newton Forward difference method and Newton Backward Difference method.
9. Integration by Trapezoidal method, Simpson method and Romberg Integration method.
10. Differentiation by Richardson extrapolation method. Ordinary differential equation by Euler method and simplified Euler method.

Books Recommended:

1. Alex Gezerlis, 2020, Numerical Methods in Physics with Python, 1st Edition, Cambridge University Press.
2. Richard L. Burden, J. Douglas Faires, 2015, Numerical Analysis, 10th Edition, Cengage Learning.
3. Steven C. Chapra, Raymond P. Canale, 2015, Numerical Methods for Engineers, 7th Edition, McGraw-Hill Education.
4. Joel Franklin, 2013, Computational Methods for Physics, 1st Edition, Cambridge University Press.
5. William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, 2007, Numerical Recipes: The Art of Scientific Computing, 3rd Edition, Cambridge University Press.

Introduction to Computer Networks -- Appl. Phys. 404 -- 2 + 1 CH

Course Objective:

This course introduces the fundamental principles of computer networks for electronics major students covering both theoretical concepts and hands-on practice, the course explores network architectures, protocols, and data communication.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Understand and explain the basic architecture and protocols of computer networks and internet.
- Design and implement simple computer networks.
- Analyze network performance and troubleshoot common network problems.

Course Outline:

Introduction to Networks: Basic Network Concepts (nodes, links), Network Topologies (Star, Bus, Ring, Mesh, Hybrid), Types of Networks/Network Architectures (PAN, LAN, MAN, WAN), Network protocols (TCP/IP, HTTP, FTP, SMTP), Network devices (routers, switches, hubs, modems), Network Models (Peer-to-Peer, Client-Server).
Introduction to TCP/IP suite: Overview of TCP/IP protocol stack.
Physical Layer: Transmission media (copper cables, fiber optics, wireless), Signal encoding techniques (digital and analog), Data transmission methods (baseband and broadband).
Data Link Layer: Framing techniques (bit stuffing, character stuffing), Error detection and correction (checksum, parity, CRC), Media Access Control (MAC) protocol, ARP, (Ethernet, VLANs, Wi-Fi)
Network Layer: IP addressing (IPv4, IPv6), Routing protocols (RIP, OSPF), Internet Protocol (IP), Internet Control Message Protocol (ICMP), Network Address Translation (NAT).
Transport Layer: Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Port numbers and Socket programming.
Application Layer: HTTP, FTP, SMTP, DNS, DHCP and its operation (DORA).

List of Experiments:

1. Understand the function and configuration of basic networking devices.
2. Learn to configure IP addresses and understand subnetting.
3. Understand VLANs (Virtual LANs) and their benefits in network segmentation.
4. Capture and analyze network packets.
5. Capture and analyze network traffic to explore miscellaneous networking protocols.
6. Learn routing principles and configure both static and dynamic routing.
7. Understand DHCP (Dynamic Host Configuration Protocol) and its role in automating IP address assignment.
8. Understand the concept and implementation of NAT.
9. Learn basic firewall principles and configuration.
10. Compare TCP and UDP protocols by analyzing traffic characteristics.

Books Recommended:

1. James F Kurose, Keith W Ross. 2024. Computer Networking: A Top-Down Approach. 8th Edition. Pearson.
2. Behrouz A. Forouzan, 2023, TCP/IP Protocol Suite, 5th Edition, McGraw-Hill Education.
3. Larry Peterson and Bruce Davie, 2021, Computer Networks: A Systems Approach, 6th Edition, Morgan Kaufmann.
4. James F. Kurose and Keith W. Ross, 2020, Computer Networking: A Top-Down Approach, 8th Edition, Pearson Education.
5. Andrew S. Tanenbaum and David J. Wetherall, 2010, Computer Networks, 5th Edition, Pearson Education.

Circuit Theory - Appl. Phys. 405 - 2 + 1 CH

Course Objectives:

This course aims to equip students with knowledge and practice of analysis and design of simple and complex electrical circuits with the help of computer-aided design tools to simulate and troubleshoot circuits.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Design and implement basic electrical circuits.
- Solve circuit problems using analytical and numerical techniques.
- Communicate technical information effectively, both orally and in writing.

Course Outline:

Basic Circuit Concepts: Charge, Current, Voltage. Circuit elements (resistors, capacitors, inductors). Kirchhoff's laws (voltage law KVL and current law KCL), Ohm's law, Power and energy in circuits.
DC Circuit Analysis: Series and parallel circuits, Mesh and nodal analysis, Thevenin's and Norton's theorems, Superposition theorem, Maximum power transfer theorem
AC Circuit Analysis: Sinusoidal steady-state analysis, Phasor analysis, Impedance and admittance, Power in AC circuits (real, reactive, and apparent power), Power factor correction.
Transient Analysis: First-order and second-order circuits, Step response and impulse response, Laplace transform and its application to circuit analysis
Three-Phase Circuits: Balanced three-phase systems, Power in three-phase systems, Unbalanced three-phase systems, Delta-Wye Transformations.
Network Theorems: Millman's theorem, Compensation theorem, Reciprocity theorem.
PSpice Simulations: Introduction to PSpice, creating and simulating circuits, DC analysis, AC analysis, transient analysis, and frequency response.

List of Experiments:

1. Kirchhoff's Laws (KVL and KCL) and multi-source resistive circuits.
2. Nodal and Mesh Analysis.
3. Analysis of Superposition Principle.
4. Thevenin's and Norton's Equivalent Circuits.
5. Maximum Power Transfer Theorem. Delta-Wye Conversion.
6. Transient and Forced Response of RC and RL Circuits.
7. Transient and Forced Response of LC and RLC Circuits
8. PSpice Simulation of Basic Circuits.
9. PSpice Simulation of Transient and AC Analysis.
10. PSpice Simulation of Frequency Response of Reactive Circuits.

Books Recommended:

1. Roland E. Thomas, Albert J. Rosa, Gregor J. Toussaint. 2023. The Analysis and Design of Linear Circuits. 10th Edition. Wiley.
2. Charles K. Alexander and Matthew N. O. Sadiku, 2021, Fundamentals of Electric Circuits, 7th Edition, McGraw-Hill Education.
3. Robert L. Boylestad and Louis Nashelsky, 2015, Introduction to Electric Circuits, 12th Edition, Pearson Education.
4. James W. Nilsson and Susan Riedel, 2015, Electric Circuits, 10th Edition, Pearson Education.
5. John Bird, 2013, Electrical Circuit Theory and Technology, 5th Edition, Routledge Pub.

Basic Electronics -- Appl. Phys. 406 -- 2 + 1 CH

Course Objective:

This course provides the student the fundamental skills to understand the basics of semiconductor and components like diode, transistor, FET, MOSFET and operational amplifier It will build mathematical and numerical background for design of electronics circuit & component value.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Understand basic electronic components and their function in an electronic circuit.
- Design simple electronic circuits using basic electronic components.
- Understand how the signals process, analyze and record in the time and frequency domains.

Course Outline:

Introduction of PN junction, Half Wave Rectifiers, Full Wave Rectifiers, power supply Filters, Voltage Regulators Circuits, Current Regulator Circuits, Power Supplies, and other applications.

Introduction of Transistor, Transistor Biasing, Transistor as an Amplifier and a Switch, Amplifier configurations, Load lines, Small signal Amplifiers, Coupling of amplifiers, Large Signal Amplifiers, Special Amplifiers, Dc Amplifiers, Differential Amplifiers, FET and their application.

Types of Oscillator Circuits, Principles Sinusoidal Oscillators, Resonance Circuits, RC oscillators, Non-sinusoidal Oscillators, Relaxation Oscillators, Multivibrators.

List of Experiments:

1. To study junction diode's and Zener diode's characteristic
2. Application of Junction diode as a clipper and clamper
3. To study rectifier and filters (half wave and bridge)
4. To study Transistor Familiarization
5. Application of transistor as a voltage regulator
6. Transistor as a Common Emitter Amplifier configurations, circuit designing and analysis.
7. Transistor as a Common Base and Common Collector Amplifier configurations, circuit designing and analysis.
8. To study power Amplifiers (class A, B and C)
9. To study FET characteristics and Amplifier
10. To study differential Amplifier
11. To study oscillator, designing and analysis

Books Recommended:

1. Albert Paul Malvino. David J. Bates and Patrick E. Hoppe, 2020. Electronic Principle. 8th Edition.
2. G. S. Tomar, Ashish Bagwari. 2020. Fundamentals of Electronic Devices and Circuits. Springer Nature Switzerland.
3. Thomas L. Floyd. 2018. Electronic Devices. 10th Ed. Prentice Hall.
4. Robert T. Paynter. 2005. Introductory Electronic Devices and Circuits. 7th Ed. Prentice Hall.
5. Morris Slurzberg & William Osterheld. 1989. Essentials of Communication Electronics. McGraw-Hill.

Quantum Mechanics - Appl. Phys. 407 - 3 + 0 CH

Course Objectives:

The course aims to introduce the fundamental principles of quantum mechanics and their applications in modern physics. It will enable students to understand the wave-particle duality of matter, the mathematical framework of quantum mechanics, and the quantum description of physical systems.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Explain the fundamental postulates and principles of quantum mechanics and their significance in describing microscopic systems.
- Apply mathematical tools such as operators, wave functions, and Schrödinger's equation to analyze and solve basic quantum problems.
- Interpret quantum phenomena, including tunneling, energy quantization, and atomic structure, in the context of real-world applications in electronics and nanotechnology.

Course Outline:

Introduction to Quantum Physics: Historical development of blackbody radiation, photoelectric effect, Compton effect; wave-particle duality and de Broglie hypothesis; Heisenberg uncertainty principle.

Quantum Mechanical Framework: Postulates of quantum mechanics; wave functions and probability interpretation; operators, observables and commutation relations.

Schrödinger Equation and Applications: Time-dependent and time-independent Schrödinger equations; particle in a box (1D, 2D, 3D); quantum tunneling and potential barriers.

Quantum Systems: The harmonic oscillator; the hydrogen atom: wave functions, quantum numbers, and atomic orbitals; spin, Pauli exclusion principle, and applications to multi-electron atoms.

Applications in Modern Physics: Quantum wells, wires, and dots (nanostructures); quantum description of semiconductors and electronic devices; introduction to quantum computing and quantum communication (overview).

Books Recommended:

1. J. S. Townsend. 2020. A Modern Approach to Quantum Mechanics. 3rd Edition. University Science Books.
2. D. J. Griffiths, and D. F. Schroeter. 2018. Introduction to Quantum Mechanics. 3rd Edition. Cambridge University Press.
3. J. J. Sakurai and J. Napolitano. 2017. Modern Quantum Mechanics. 2nd Edition. Cambridge University Press.
4. R. Shankar. 2011. Principles of Quantum Mechanics. 2nd Edition. Springer.
5. N. Zettili. 2009. Quantum Mechanics: Concepts and Applications. 2nd Edition. Wiley.

Introduction to Renewable Energy -- Appl. Phys. 408 – 3 + 0 CH

Course Objective:

Provide students with a comprehensive understanding of renewable energy sources and their importance in reducing carbon emissions. Explore technologies such as solar, wind, and biomass, with emphasis on technical applications, economic feasibility, and sustainability.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Analyse the environmental and economic benefits of renewable energy compared to fossil fuels.
- Understand the fundamentals and working principles of various renewable energy systems.
- Assess challenges and solutions in implementing renewable energy on a global scale.

Course Outline:

Energy basis, units, energy and power, energy sources, historical development and trends of energy sources, conventional energies, renewable energies, potential of energy sources, essentials of fluid dynamics, Heat transfer.

Energy and environment, problems related with energy sources, air pollution, acid rain, greenhouse effects, climate change and sustainable development.

Overview and Applications of Renewable Energy Sources including Wind Energy, Solar Energy, Biomass Energy, Geothermal Energy, Tidal Energy, Wave Energy, Hydro Energy, Introduction to New Storage Technologies.

Books Recommended:

1. Nick Jenkins, Janaka Ekanayake. 2024. Renewable Energy Engineering. 2nd Edition. Cambridge University Press.
2. John Twidell, Tony Weir. 2024. Renewable Energy Resources. 1st Edition. Taylor & Francis.
3. Daniel Kirschen. 2024. Power Systems: Fundamental Concepts and the Transition to Sustainability. 1st Edition. University of Washington Press.
4. Robert Ehrlich, Harold A Geller. 2018. Renewable Energy: A First Course. 2nd Edition. Taylor & Francis.
5. Vaughn C Nelson, Kenneth L Starcher. 2015. Introduction to Renewable Energy. 2nd Edition. Chapman and Hall/CRC.

Linear Integrated Circuits -- Appl. Phys. 501 -- 3 + 0 CH

Course Objective:
Introduce the basic concepts of Operational amplifier and its applications. To study the basics of other Linear integrated circuits like 555 Timer, PLL, OTA's and voltage regulators and circuit designing by using them.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Develop skills to understand basic concepts of operational amplifier and design the circuit using op-amp
- Develop skills to solve the problems related to the operational amplifier based circuits.
- Gain knowledge about all other Linear integrated circuits design the circuits by using them and solve related problems

Course Outline:
Introduction and characteristics of op-amp, Basic amplifiers using op-amp with negative feedback, Basic op-amp circuits without negative feedback, Basic non-linear application of operational amplifier, Integrator and differentiator circuit using op-amp, Active filters.
Introduction & description of functional diagram, multivibrators using 555 Timer, Schmitt trigger, Frequency divider, PAM, PWM, PPM.
Phase Lock Loop, Operational Transconductance amplifier, Instrumentation amplifier, Isolation amplifier, Linear voltage regulators, Switching Regulators.
Introduction & Classification, IC chip size and Circuit Complexity, Fundamental of Monolithic IC Technology, Basic Planar Processes, Fabrication of Typical circuit, Active and Passive components of ICs, Fabrication of FET, Thin and Thick film Technology.

Books Recommended:

1. Gayakwad, Ramakant A. 2020. Op-Amps and Linear Integrated Circuits. 4th Edition. Prentice-Hall of India.
2. Roy Choudhury D. 2018. Linear integrated Circuit. 4th Edition. New Age International (P) Ltd.
3. Roy Choudhury D. 2010. Linear integrated Circuit. 2nd Edition. New Age International (P) Ltd.
4. Thomas L. Floyd. 2007. Electronic Devices. 8th Ed. Prentice Hall.
5. Robert T. Paynter. 2005. Introductory Electronic Devices and Circuits. 7th Ed. Prentice Hall.

Communication Electronics -- Appl. Phys. 502 -- 3 + 0 CH

Course Objective:
Equip students with foundational knowledge in communication electronics, focusing on circuit components, modulation techniques, and signal processing methods essential for modern communication systems.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Demonstrate understanding of key communication circuit components like amplifiers, mixers, and oscillators.
- Design and implement modulation and demodulation circuits for signal transmission.
- Analyse the performance of communication systems under different operating conditions.

Course Outline:
Modulation and their types, Amplitude modulation principles, Assignable frequency spectrum, AM modulators, Heising Modulation, Heat sinking, Double Modulation, Neutralization, Sideband transmission, Methods of separating sidebands, Balanced modulators, Superhetrodyne receivers, Double conversion receivers, Independent sideband receivers, Frequency synthesis, AM stereo, Frequency modulation principles, Direct frequency modulation, Narrow-band FM, Reactance modulators, Phase modulators, FM detectors, stereo FM, RF antennas Half-wave and folded dipole antennas, Parasitic array antennas, Radiation patterns and other parameters, antenna stacking, Marconi antennas, impedance matching to antennas.

Books Recommended:

1. Wayne Tomasi. 2024. Electronic Communications Systems, 5th Edition. Pearson PTR.
2. Michael Fitz. 2024. Fundamentals of Communication Electronics. 1st Edition. Wiley.
3. Martin S Roden. 2024. Analog and Digital Communication Systems. 1st Edition. Oxford University Press.
4. M Anand. 2022. Modern Electronics and Communication Engineering. 1st Edition. CRC Press.
5. Anand Mahajan. 2022. Electronics & Communication Engineering Vol-2. Kindel Edition.

Laser and Applied Optics -- Appl. Phys. 503 -- 3 + 0 CH

Course Objective:

Provide students understanding about the basic concepts of Laser and Applied optics and information about the construction and working of different types of Lasers. It also provides concepts of recording and retrieving information in the different fields by using laser.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Develop skills with sufficient background in the Physics of Lasers and their applications
- Understand the use of lasers in Industry, Medical facilities, Fiber Optics communication among others.
- Develop understanding about the behavior of light essential for the invention of optical instruments.

Course Outline:

Principles of Optical Design, Matrix Formulation of Geometrical Optics; Image Formation, Radiometry and Photometry, Modern Theory of Diffraction and Interference Fourier Optics, Coherence and Statistical Optics, Polarization.

Light Amplification, Population inversion, Amplifier Nonlinearity and Gain saturation, Theory of laser Oscillation, Optical Resonators, cavity resonator, optical nonlinearity, Modes, Rate Dynamics of Three Level and Four Level Lasers, Q-Switching and mode Locking, Solid Sate Lasers, Semiconductor lasers, Dye lasers.

Spatial Filtering, Holography, Laser Remote sensing, laser Spectroscopy, Industrial Applications, Application in Medicine and Chemistry.

Books Recommended:

1. Prem B Bisht, 2022. An Introduction to Photonics and Laser Physics with Applications. IOP Publishing Ltd.
2. Hans Joachim Eichler, Jürgen Eichler. Oliver Lux, 2018. Lasers: Basics, Advances and Applications. Springer Series in Optical Sciences.
3. Dieter Meschede. 2017. Optics, Light and Lasers: The Practical Approach to Modern Aspects of Photonics and Laser Physics. 3rd Edition. Wiley
4. Dieter Meschede. 2007. Optics, Light and Lasers: The Practical Approach to Modern Aspects of Photonics and Laser Physics. 2nd Edition. Wiley
5. Matt Young. 1992. Optics and Lasers including Fibers and Optical Waveguide. 4th edition. Springer Nature link

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Semiconductor Devices -- Appl. Phys. 504 -- 3 + 0 CH

Objective:
Introduce students to the physical principles, behaviour, and applications of semiconductor devices, with a focus on materials, P-N junctions, transistors, and their role in modern electronics.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Describe the properties of semiconductors and how they affect device performance.
- Understand the operation of diodes, BJTs, and MOSFETs.
- Apply semiconductor device models to analyze and design basic electronic circuits.

Course Outline:
Semiconductor Material, Elemental and compound. Fermi-Dirac Distribution. Intrinsic, extrinsic and compensated Semiconductor. Mobility, Drift and Diffusion processes. Carrier generation and recombination, Quasi-Fermi levels. Formation of P-N junction. Biased P-N junction. Non- uniformly doped junctions, Linearly Graded and Hyper abrupt junctions. Metal-Semiconductor contacts and Hetero-Junctions. Bipolar transistor, Metal-Oxide Semiconductor Field Effect Transistor (MOSFET), Junction Field Effect Transistors (JFET). Photonic Devices, Avalanche Diodes and Quantum Wells, Thyristors, Gunn diode, PIN diode, 2D semiconductors.

Books Recommended:

1. Sima Dimitrijev. 2024. Principles of Semiconductor Devices. 1st Edition. Oxford University Press.
2. Betty L Anderson, Richard L Anderson. 2023. Fundamentals of Semiconductor Devices. 2nd Edition. McGraw-Hill Education.
3. Robert F Pierret. 2023. Semiconductor Device Fundamentals. 1st Edition. Pearson.
4. Simon M Sze, Kwok K Ng, Yiming Li. 2021. Physics of Semiconductor Devices. 4th Edition. Wiley.
5. Tiwari Sandip. 2020. Semiconductor Physics: Principles, Theory and Nanoscale Vol 3. Electroscience Series.

Power Electronics -- Appl. Phys. 505 -- 3 + 0 CH

Course Objective:

Enables students to understand power electronics systems to control, regulate and manage electric power with high efficiency, reducing power losses. The main objective is to develop skills to devise efficient, compact, and economical techniques for transforming and regulating electrical energy between different forms.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Describe basic operation and performance of various power semiconductor devices, passive components and switching circuits.
- Design and Analyze power converter circuits and power electronic circuits at the system level and asses the performance.
- Identify the critical area of application, typical alternate solution and select suitable power electronic circuits in industrial grade apparatus, other emerging areas.

Course Outline:

Definition of Power Electronics, Key characteristics, Power Devices, Power Diode, Power Transistors, Power MOSFET, Insulated-Gate Bipolar Transistor (IGPT), Thyristors (SCR, TRIAC and GTO), SCR Commutation Techniques, Converters Half wave and full wave uncontrolled rectifiers Half wave and full wave-controlled rectifiers Semi converters and full converters Three phase uncontrolled and controlled rectifiers. DC-DC Convertor Concept of Chopper Buck Converter Boost Converter Buck Boost Converter CUK Converter Fly Back Converter Forward Converter Switch mode power Supplies Inverters Single phase half bridge and full bridge inverters. PWM controlled single phase inverters. Three phase inverters with 120 and 180 degree conduction. AC-AC converters. Cycloconverter Link Converter DC and AC Derives Automotive Applications of Power Electronics.

Books Recommended:

1. Ned Mohan, Siddharth Raju. 2022. Power Electronics, A First Course. 2nd Edition. John Wiley & Sons.
2. Weidong Xiao. 2021. Power Electronics Step-by-Step: Design, Modeling, Simulation, and Control. 1st Edition. Mc Graw Hill.
3. Issa Batarseh, Ahmad Harb. 2019. Power Electronics: Circuit Analysis and Design. Springer.
4. Slobodan Cuk. 2015. Power Electronics: Modeling. Analysis and Measurements. Create Space Independent Publishing Platform
5. Daniel W. Hart. 2010. Power Electronics. 1st Edition. McGraw Hill.

Digital Logic Design -- Appl. Phys. 506 -- 1 + 2 CH

Course Objective:
Provide a strong foundation in the principles and applications of digital logic, including binary systems, combinational and sequential logic, essential for digital circuit design.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Design and analyse combinational and sequential digital circuits.
- Understand binary arithmetic, Boolean algebra, and logic simplification.
- Use logic design techniques to implement digital systems with real-world applications.

Course Outline:
Introduction to fundamentals of digital logic design and FPGA; overview of combinational vs sequential design logics; introduction to FPGAs architecture and programming basics; introduction to the FPGA design flow i.e. simulation, synthesis and implementation.
Basic combinational logic design and VHDL fundamentals: VHDL Basics; operators and basic VHDL statements; designing basic combinational circuits.
Advanced combinational logic design with VHDL: conditional and selective signal assignment; designing larger combinational circuits; introduction to testbenches for combinational logic testing.
Sequential logic design using VHDL: understanding sequential circuits; VHDL processes and clock management; designing counters and shift registers with VHDL.
Finite state machines (FSMs) and control logic: basics of finite state machines; Mealy and Moore models; design and coding of FSMs in VHDL; application of FSMs in digital systems.
Advanced FPGA concepts and optimization techniques: VHDL libraries, packages and configurations; introduction to IP cores and pre-built FPGA modules; timing analysis and resource optimization for FPGA.

List of Experiments:

1. Getting started with FPGA tools (Xilinx Vivado or Intel Quartus) – basic FPGA setup and LED blinking project.
2. Writing VHDL code for combinational circuits.
3. Implementing combinational circuits (2-to-1 MUX, encoder) on FPGA.
4. Designing and simulating a 4-Bit adder.
5. Implementation of a comparator on FPGA with VHDL.
6. Designing and testing a 4-Bit counter on FPGA.
7. Implementing and simulating shift registers on FPGA.
8. Designing and testing an FSM-based sequence detector.
9. Implementing a traffic light controller using FSMs on FPGA.
10. Integrating IP cores (multiplier module).
11. Testing and optimizing FPGA design performance.

Books Recommended:

1. Brian Holdsworth, Clive Woods. 2024. Digital Logic Design. 4th Edition. Newnes.
2. Cem Unsalan, Bora Tar. 2023. Digital System Design with FPGA: Implementation Using Verilog and VHDL. 1st Ed. McGraw-Hill Education.
3. Stephen Brown, Zvonko Vranesic. 2022. Fundamentals of Digital Logic with VHDL Design. 4th Edition. McGraw-Hill Education.
4. Morris Mano, Charles R Kime. 2021. Logic and Computer Design Fundamentals. 5th Edition. Pearson.
5. Michael D Ciletti. 2020. Advanced Digital Design with the Verilog HDL and VHDL. 1st Ed. Pearson.

Solid State Physics -- Appl. Phys. 507 -- 3 + 0 CH

Course Objective:

Enables students to understand the behaviour of solid and develop skills to exploring the structure of solid. It develop understanding of the fundamental principles governing the behavior of solids, solid state physics contributes to the advancement of various technologies, including electronics, photonics, and materials science.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Describes the properties of solids from a unified point of view based essentially on the quantum properties of electrons within crystalline materials.
- Understand how the large-scale properties of solid materials result from their atomic-scale properties.
- Understand the role of materials physics in the development of modern technology, and the physical processes on which these technologies are based.

Course Outline:

Crystal Structures: Crystalline and amorphous solids. Bravais and Non- Bravais lattices and their properties. Planes and directions in crystals. Crystal structures analysis techniques. Atomic scattering factor and Geometrical structure factors. Reciprocal lattices.

Lattice Dynamics: One dimensional mono and diatomic vibrations. Dispersion curves. Inelastic scattering for study of dispersion curves of real crystals. Specific heat models. Thermal conductivity of insulators. Thermal expansion.

Free Electron Theory of Metals: Electrical conductivity, thermal conductivity and Specific heat of metals based upon Drude & Lorentz and Sommerfeld models.

Band Theory of Solids: Motion of electron in a periodic potential. Development of energy Bands. Brillioun zones. Dynamics of electron in a band. (Concept of free electron, effective mass, hole. etc.) Nearly free electron and tight binding approximation. Classification of solids. Application of NFE on real metals (i.e. Brillioun zones and Fermi surfaces of metals.).

Dielectric & Magnetic Properties of Solids: Macroscopic and microscopic view of Dielectrics. Sources of Dielectric polarizability Electronic polarizability. Ionic polarizability Piezoelectricity and Electrostriction Ferroelectrics, Magnetic dipole strength. Diamagnetism, Paramagnetism and Ferromagnetism. Spin Ferromagnetic domains. Anti-ferromagnetism and Ferrimagnetisms.

Books Recommended:

1. Kittel, Charles. 2021. Introduction to solid state physics. Vol. 8. New York: Wiley.
2. Snoke, David. 2020. Solid state physics: Essential concepts. Cambridge University Press.
3. McKelvey, John P. 2018. Solid state and semiconductor physics. Harper & Row.
4. R.K. Puri. 2004. Solid State Physics. Chand & Company Ltd.
5. M. Ali Omar. 1993. Elementary Solid State Physics. 4th Edition. Addison Wesley.

Industrial Electronics & Automation -- Appl. Phys. 508 -- 3 + 0 CH

Course Objective:
Prepare students to work with electronic systems in industrial automation, including power electronics, control systems, and PLCs, emphasizing practical applications and efficiency.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Demonstrate understanding of power electronics and control systems in industrial contexts.
- Implement basic programmable logic controller (PLC) operations for automation.
- Analyse efficiency and reliability considerations in industrial electronic systems.

Course Outline:
Control Devices Switches: Manual and Automatic Switches Mechanical, Electromechanical, Solenoids and Electronic Switches, Applications Thyristors SCR, TRIAC, DIAC, UJT and PUT, Time Delay Circuits: Passive and active time delay circuits, Phase Shift Control: SCR and Triac circuits for phase shift control.
Generators: Working Principle, DC Generator. Types and their characteristics, AC fundamentals. Three phase system, AC generators single and poly phase, DC Motors Working Principle, Types, construction and characteristics, Speed control of DC motors.
AC motors: Rotating magnetic field, Induction motor. Concept of slip, Synchronous motor, Starting of synchronous motor. Speed control, Power Factor and methods of improving power factor, Single Phase motors. Split phase motors, Single phase ac synchronous motors.
Special types of motors: Stepper motors, Servo motors, Universal motor.
Sensors & Transducers: Transducers & Transmitter, Active & Passive transducers, Temperature, Humidity, Light, Pressure, Displacement, Flow and Level transducers
Process Control: Process characteristics, On-Off, Proportional, Integral, Differential and PID controllers.
Programmable Logic Controllers (PLC): Symbolic, Design of sequential control using Ladder Logic. Architecture of PLC, Instruction Set, Languages such as Statement List (STL), Functional Block Diagrams (FBD) and Graphical Flow. Analog Interfacing.
Supervisory Control & Data Acquisition (SCADA) and Distributed Control Systems (DCS).

Books Recommended:

1. Ali Emadi. 2023. Industrial Electronics: Devices and Systems. 2nd Edition. McGraw-Hill.
2. Jean Westcott, Sean Westcott. 2023. Industrial Automation and Robotics. 2nd Edition. De Gruyter.
3. James A Rehg. 2022. Industrial Electronics. 6th Edition. Cengage Learning.
4. Timothy L Skvarenina. 2022. Modern Industrial Electronics. 2nd Edition. Prentice Hall.
5. Terry L M Bartelt. 2022. Industrial Control Electronics: Devices, Systems & Applications. 2nd Edition. Pearson.

Digital Electronics -- Appl. Phys. 509 -- 2 + 1 CH

Course Objective:

To provide basic knowledge of digital logic levels and its application to understand digital electronics circuits. To prepare students to perform the analysis and design of various digital electronic circuits.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Develop thorough understanding of the fundamental concepts and techniques used in digital electronics.
- Develop skills to understand, analyze and design various combinational and sequential circuits.
- To develop skills to build and troubleshoot digital circuits.

Course Outline:

Combinational logic: Binary number representation; 2's complement and 1's complement, basic logic gates AND, OR, NOT, EX-OR/NOR; universal logic gates NAND/NOR; Karnaugh mapping for logical statement minimization; identification of static hazard conditions.

Combinational logic applications: Full adder/subtractor; carry look ahead; simple encoders; parity checking; use of digital simulator.

List of Experiments:

1. Verify the proper operations of NOT, AND, OR, NAND, NOR logic gates.
2. Verify the proper operations of Exclusive-OR and Exclusive-NOR logic gates.
3. Verification of laws of Boolean algebra using logic gates.
4. Observe the proper operation of a Multiplexers and its use as a function generator.
5. Verify the operation of a 1-of-4 Decoders and its use as a de-multiplexer.
6. Learn BCD code and study the operation of an 8421 Decimal Decoder driver.
7. Operation and connection of a BCD-to-seven-segment decoder driver to a seven-segment LED display.
8. Verify the operation of binary Adders and 8-input Priority Encoder.
9. Construct and verify the operation of SR and JK flip-flops.

Books Recommended:

1. Ronald J. Tocci, Neal S. Widmer, and Gregory L. Moss. 2022. Digital Systems: Principles and Applications. 12th Ed, Pearson.
2. Roger L. Tokheim, Patrick E. Hoppe. 2021. Digital Electronics: Principles and Applications. 9th Ed. McGraw-Hill.
3. Thomas L. Floyd. 2015. Digital Fundamentals. 11th Ed. Prentice Hall.
4. A. Anand Kumar. 2009. Fundamentals of Digital Circuits. First edition. Prentice Hall of India.
5. William Kleitz. Digital Electronics: A Practical Approach. 8th Ed. 2008. Prentice Hall.

Signal and Systems -- Appl. Phys. 510 -- 3 + 0 CH

Course Objective:
Introduce students to the analysis and representation of signals and systems in both continuous and discrete time, with applications in engineering fields such as communications and control.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Analyse signals in both time and frequency domains.
- Understand the fundamental concepts of system properties such as linearity and stability.
- Apply transform techniques (e.g., Laplace, Fourier, Z-Transform) to analyse systems.

Course Outline:
Introduction to the fundamentals of continuous and discrete time signals and systems analysis. , Introduction to sampling and sampling theorem, Linear Continuous and Discrete Time Systems, Time Domain Analysis of Continuous Time Systems, Convolution and Impulse Response, Spectral Analysis of Continuous Time Systems, Fourier Series, Fourier Transforms, Analysis of Continuous Time Systems using the Laplace Transform and applications, Filters, Discrete Time Systems, Frequency Domain Analysis, Time Domain Analysis, Introduction to Z-Transforms**.**

Books Recommended:

1. P P Vaidyanathan. 2024. Signals, Systems, and Signal Processing. 1st Edition. Cambridge University Press.
2. Sarhan Musa, Matthew Sadiku, Warsame Ali. 2024. Signals and Systems: A Practical Approach. 1st Edition. Taylor & Francis.
3. Michael J Roberts. 2018. Fundamentals of Signals and Systems. 3rd Edition. McGraw-Hill Education.
4. Fred Taylor. 2018. Principles of Signals and Systems. 2nd Edition. McGraw-Hill Education.
5. Rodger E Ziemer, William H Tranter, Ronald Fannin. 2014. Signals and Systems. 4th Edition. Pearson.

Experimental Electronics I -- Appl. Phys. 511 -- 0 + 3 CH

Course Objective:

Develop skill to design an electronic circuits using op-amp and other linear integrated circuits. Trouble shoot the errors. Analyze the response in time and frequency domain.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Develop skills to use linear ICs to design various applications.
- Develop skills to troubleshoot the errors of linear and nonlinear circuits based on ICs.
- Develop skills to handle measuring instruments to troubleshoot the circuits.

List of Experiments:

1. To study Differential Amplifier
2. To observe Operational Amplifier Characteristics
3. To study Basic Operational Amplifier Circuits
4. To analyze Linear applications of Operational Amplifier
5. To study Basic Operational Amplifier Circuits without negative feedback
6. To study OP AMP Oscillators
7. To analyze Frequency Response and Filters
8. To study 555 Timer & its basic applications
9. To study OTA circuits
10. To study AM and FM using 555 timer & OTA
11. To study PAM, PWM and PPM using 555 timer
12. To study Phase Locked Loop
13. To study Regulated power supply using linear regulator IC
14. To study Switching Regulators

Books Recommended:

1. Gayakwad, Ramakant A. 2020, Op-Amps and Linear Integrated Circuits. 4th Edition.
2. Roy Choudhury D, 2018. Linear integrated Circuit. 4th Edition. New Age International (P) Ltd.
3. Roy Choudhury D., 2010. Linear integrated Circuit. 2nd Edition. New Age International (P) Ltd.
4. Thomas L. Floyd, 2007. Electronic Devices. 8th Ed. Prentice Hall.
5. Robert T. Paynter. 2005. Introductory Electronic Devices and Circuits. 7th Ed. Prentice Hall.

Experimental Electronics II -- Appl. Phys. 512 -- 0 + 3 CH

Course Objective:
Develop practical skills in electronic circuit assembly, testing, and troubleshooting, fostering a hands-on understanding of circuit design and electronic principles related to industrial controls and PLC.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Construct and test circuits to reinforce theoretical knowledge of industrial control electronics.
- Use measurement instruments (oscilloscopes, multimeters) to troubleshoot circuits.
- Interpret experimental results to evaluate circuit performance related to industrial control and PLCs.

List of Experiments:

1. To design relaxation oscillator using UJT and PUT
2. To construct and study Ramp-Pedestal circuit, and time delay circuits
3. Power control using insulated-gate bipolar transistor (IGBT) and its applications.
4. Power control using load using thyristors (SCR, TRIACS)
5. Manual and electronic control of DC and stepper motors
6. Study ON-OFF proportional and proportional integrated process control
7. Build and perform a closed loop temperature controller using LM-35 temperature sensor.
8. Introduction to PLC, Ladder, STL and FBD programming
9. Combinational and sequential logics implementation on PLCs
10. Timer, counter and data movement
11. Analog i/o , RTD, Thermocouple and load cell modules interfacing.
12. Programming of HMI
13. Interfacing of different sensors and output devices with PLCs.
14. Control of pneumatic system using PLCs, Study of operation of VFD.

Books Recommended:

1. Ali Emadi. 2023. Industrial Electronics: Devices and Systems. 2nd Edition. McGraw-Hill.
2. Jean Westcott, Sean Westcott. 2023. Industrial Automation and Robotics. 2nd Edition. De Gruyter.
3. James A Rehg. 2022. Industrial Electronics. 6th Edition. Cengage Learning.
4. Timothy L Skvarenina. 2022. Modern Industrial Electronics. 2nd Edition. Prentice Hall.
5. Terry L M Bartelt. 2022. Industrial Control Electronics: Devices, Systems & Applications. 2nd Edition. Pearson.

Microprocessor Architecture & Programming -- Appl. Phys. 601 -- 2 + 1 CH

Course Objective:
Introduce students to the architecture, operation, and programming of microprocessors, covering assembly language and interfacing with peripheral devices.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Understand microprocessor components and their functions in data processing.
- Write and debug assembly language programs for basic microprocessor operations.
- Interface microprocessors with peripherals for specific applications.

Course Outline:
Basic Microprocessor Architectural Concepts, Microprocessor Architecture- Families, Intel Microprocessors an Introduction, Pinout and Instruction set, Assembly Language Programming, Assembly Language Programming Techniques, IF-THEN-ELSE Structures, Procedures and Macros, Instruction Descriptions and Assembler Directives, Communicating with Microprocessors, Microprocessor I/O, Operating System and System Software, 32/64 bit Microprocessors, Architecture and Instruction set, Memory and Task Management Hardware Features, Coprocessors and Other Advance Microprocessors, Microcontrollers, Architecture of Microcontrollers, Instruction sets. Application of Microcontrollers. Introduction to Transputers.

List of Experiments:

1. Introduction to assembly program development tools (Debug and CodeView)
2. Data transfer instruction Group
3. Arithmetic and Logic instruction Group
4. Unconditional and conditional jump instruction
5. Procedures and software interrupts
6. String manipulation instruction group
7. Disk I/O in assembly language
8. Bios routines

Books Recommended:

1. Grant McFarland. 2024. Microprocessor Design: A Practical Guide from the Gateway. 1st Edition. CRC Press.
2. Lyla B Das. 2024. The X86 Microprocessors: Architecture and Programming (8086 to Pentium). 1st Edition. Pearson.
3. Ajay V Deshmukh. 2023. Microprocessors and Microcontrollers: Architecture, Programming and Applications. 2nd Edition. Tata McGraw-Hill Education.
4. A K Ray, K M Bhurchandi. 2023. Introduction to Microprocessors: Architecture and Programming. 3rd Edition. Pearson.
5. Douglas V Hall, S S S P Rao. 2017. Microprocessors and Its Interfacing. 3rd Edition. Mc Graw Hill.

Digital Signal Processing -- Appl. Phys. 602 -- 2 + 1 CH

Course Objective:
Equip students with knowledge of DSP principles, including discrete-time signals, system analysis, and practical applications in areas like audio and image processing.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Perform signal analysis using discrete-time processing techniques.
- Design digital filters to meet specific signal processing requirements.
- Apply DSP methods in practical applications like audio enhancement.

Course Outline:
Introduction to DSP: Overview of DSP applications, advantages of digital over analog processing.
Discrete-Time Signals and Systems: Sampling, aliasing, discrete-time signals, and systems.
Transforms: Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Z-transform.
Digital Filters: FIR and IIR filter design, filter structures, and implementation.
DSP Algorithms: Convolution, correlation, spectral analysis.
Practical Applications: Audio and image processing, communication systems.

List of Experiments:
1. Introduction to MATLAB for DSP.
2. Sampling and Aliasing.
3. Discrete-Time Signal Analysis.
4. DFT and FFT Implementation.
5. FIR Filter Design and Implementation.
6. IIR Filter Design and Implementation.
7. Convolution and Correlation.
8. Spectral Analysis.

Books Recommended:

1. Li Tan, Jean Jiang. 2024. Digital Signal Processing: Fundamentals and Applications. 3rd Edition. Elsevier.
2. Maurice Bellanger, Benjamin A Engel. 2024. Digital Signal Processing: Theory and Practice. 10th Edition. Wiley.
3. John H Lilley, Jack C Johnson. 2023. Introduction to Digital Signal Processing. 4th Edition. Wiley.
4. Samuel D Stearns, Donald R Hush. 2023. Digital Signal Processing with Examples in MATLAB. 4th Edition. Wiley.
5. Thomas Holton. 2021. Digital Signal Processing: Principles and Applications. 1st Edition. Cambridge University Press.

Microwave Communication -- Appl. Phys. 603 -- 2 + 1 CH

Course Objective:
Explore microwave communication principles, including wave propagation, microwave circuits, and antennas, with applications in modern communication systems.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Analyse wave propagation and transmission line characteristics at microwave frequencies.
- Design basic microwave circuits, including amplifiers and oscillators.
- Apply principles of antenna design for microwave communication systems.

Course Outline:
Guided medium; transmission lines, losses in transmission lines, quarter-wavelength and half-wavelength transmission lines, Reactance properties of transmission lines, transmission line components, waveguides and their types, Waveguide coupling, matching and attenuation, Method of exciting waveguides, Waveguide as cavity resonators, Auxiliary components of waveguide. Unguided medium: radiation and propagation of waves, Effects of environment, Natural modes of communications, tropospheric scatter propagation, Microwave antennas, Resonant and non-resonant antennas, Effects of ground on antennas, antenna coupling at medium frequencies, directional antennas, wideband and special purpose antennas, Phase array antennas. Specialized tubes and circuits, multicavity klystron, reflex klystron, magnetron their practical considerations and performance, traveling-wave tubes their types performance and applications. Semiconductor microwave devices, high frequency limitations, Microwave devices; Varactor and step recovery diodes, parametric amplifiers, Negative resistance amplifiers, Gunn diodes, IMPATT diodes and other Semiconductor devices. RADARS; range relations, radar performance factors, Pulsed radar systems, antennas and scanning mechanism, display methods, radar beacons, other radar systems.

List of Experiments:

1. Video and voice communications with microwave links.
2. VSWR measurements and TX line impedance.
3. Frequency and wavelength measurements.
4. Power measurements and line attenuation.
5. Transmission line tuning.
6. Hybrid-T wave guide.
7. Three port directional coupler.
8. Gunn oscillator
9. Horn antenna gain calculations and measurements
10. Power gain and beam width horn measurements
11. H and E plane patterns
12. Microwave transmitters and receiver.

Books Recommended:

1. Diptiranjan Samantaray, Somak Bhattacharyya. 2024. Microwave Devices and Circuits for Advanced Wireless Communication. 1st Edition. Taylor & Francis.
2. Luis S M Santos, L Mendes. 2023. Microwave Communications: Principles and Applications. 1st Edition. CRC Press.
3. R K Shevgaonkar. 2023. Microwave Engineering: Active and Passive Design. 2nd Edition. Wiley.
4. S B Shinde. 2023. Fundamentals of Microwave Communication. 1st Edition. Oxford University Press.
5. Louis E Frenzel. 2016. Principles of Electronic Communication Systems, 4th Edition. McGraw Hill Education.

Microprocessor Interfacing -- Appl. Phys. 604 -- 1 + 2 CH

Course Objective:
Provide students with an understanding of interfacing techniques for 8051 microprocessor, focusing on peripheral devices and data transfer mechanisms.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Describe and implement data transfer techniques, including polling and interrupt-driven I/O.
- Interface microprocessors with peripherals, such as ADCs, DACs, and serial communication modules.
- Design simple applications demonstrating microprocessor interfacing.

Course Outline:
Introduction to computing, The 8051 microcontroller, 8051 Assembly language programming, Jump, loop and call instructions, I/O port programming, 8051 addressing modes, Arithmetic and logic instructions and programs, 8051 programming in C, 8051 hardware connection and Intel HEX file.
8051 timer programming, 8051 serial port programming, Interrupts programming, LCD and keyboard interfacing, ADC, DAC and sensor interfacing, 8051 interfacing to external memory, 8051 interfacing with 8255, RTC interfacing and programming, Motor control: relay, PWM, DC and stepper motor.

List of Experiments:
1. Interfacing of Clock, Reset and De-multiplexing circuits
2. Memory Address Decoding circuit interfacing
3. RAM and ROM circuit interfacing
4. Interfacing of 82C55 PPIA
5. Interfacing of intelligent LCD
6. 16 Keys Keyboard Interface
7. Stepper Motor interface
8. DC Motor speed control interface
9. Interfacing ADC and DAC to the 8051 microcontroller
10. Dot Matrix LED display interface

Books Recommended:

1. D R Solanke, C R Chaudhari. 2024. 8051 Microcontroller: Programming and Interfacing. 1st Edition. COSMAS Scientific Publications.
2. William H Gothmann. 2023. Introduction to Microcontrollers with 8051. 3rd Edition. Prentice Hall.
3. Walter A Schneider. 2023. 8051 Microcontrollers: An Introduction. 1st Edition. Wiley.
4. S V S Murthy. 2023. 8051 Microcontroller: Internals, Instructions, Programming, and Interfacing. 2nd Edition. O'Reilly Media.
5. Alan Clements. 2022. The 8051 Microcontroller: A Systems Approach. 2nd Edition. Pearson.

Control System -- Appl. Phys. 606 -- 3 + 0 CH

Course Objective:
Introduce control system theory, focusing on the modelling, analysis, and design of feedback systems used in engineering applications.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Model dynamic systems and understand their behaviour using mathematical representations.
- Design and analyse feedback control systems for stability and performance.
- Apply control strategies in practical engineering applications, including automation and robotics.

Course Outline:
Mathematical Models of Physical Systems, Reviewing of Laplace Transform, Transfer Functions and System Response, First order and Second order systems, Higher order systems, Feedback Control Systems, PID Control Systems,Routh's Method, Root Locus Analysis and Design, Frequency Response Analysis and Design, Nyquist diagram and stability criterion, Bode Diagrams and analysis, State Space Analysis and Design, Analogue Control Systems, Digital Control Systems, Digital Control Using Microprocessors and DSP Processors, Computer Controlled Systems.

Books Recommended:

1. P A Fadare, M A Jibril. 2023. Introduction to Control Systems. 1st Edition. Taylor & Francis.
2. B C Kuo, Farid Golnaraghi. 2023. Control Systems: Theory and Applications. 2nd Edition. Wiley.
3. Norman S Nise. 2023. Control Systems Engineering. 8th Edition. Wiley.
4. S Palani. 2022. Automatic Control Systems: With MATLAB. 2nd Edition. Springer International Publishing.
5. M Gopal. 2022. Control Systems: Principles and Design. 4th Edition. McGraw-Hill Education.

Elective Courses (For Semester VII & VIII)

Introduction to Nanotechnology -- Appl. Phys. 611 -- 3 + 0 CH

Course Objective:

This course will provide an overview of nanotechnology and demonstrate why nanoscale regime is different from microscale and bulk regime which results new paradigm in physics.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Gain basic knowledge of nanoscience and nanotechnology and will understand different types of nanomaterials.
- Gain in-depth knowledge of quantum effects, nanoscale materials, and unique phenomena that emerge at the nanoscale.
- Understand the interdisciplinary nature of nanoscience and nanotechnology.

Course Outline:

General Concepts and history of Nanotechnology, Classification of different areas of nanotechnology; Top-down Approach, Bottom-up Approach, What does nanotechnology offer for our future, Nano-Physics and Nano-Chemistry; Quantum Mechanics: The Physics of Smallness, Why electron flow, Electron conduction in nanoscale materials, diffusive and ballistic conductance, Drude formula, Density of states, Number of modes, electronic properties of molecules, carbon nanotubes and crystals, including energy band formation and the origin of metals, insulators and semiconductors. Quasi Fermi levels, Current flow in quasi Fermi levels, Boltzmann equation, Spin voltages, Heat and current, Seebeck coefficient, future electronics Electrochemistry and Electrochemical Nanotechnology, Nanostructures, Formation of Aerogels, Properties of Aerogels, Applications of Aerogels, Fullerenes: Buckyballs, The Structure of Buckminsterfullerene, Fullerene Properties, Carbon Nanotubes, Synthesis of CNTs, Properties of CNTs, Application of CNTs, Nanowires, Quantum Wells, Quantum Wires, and Quantum Dots, Carbon Nanofoam and Graphene, Generation of graphene sheets, properties of magical graphene, transition metal dichalcogenides and their properties.

Books Recommended:

1. Massimo F Bertino. 2022. Introduction to Nanotechnology. World Scientist.
2. Changzheng Wu. 2017. Inorganic Two-dimensional Nanomaterials: Fundamental Understanding. Characterizations and Energy Applications. First edition.Royal Society of Chemistry.
3. B S Murthy, P Shankar, Baldev Raj, B B Rath and James Murday. 2013. Textbook of Nanoscience and Nanotechnology. First edition. Universities Press.
4. William D. Callister, Jr., David G. Rethwisch. 2011. Fundamentals of Materials Science and Engineering. 4th Ed. John Wiley & Sons, Inc.
5. Massimiliano Di Ventra, Stephane Evoy, Randy Heflin. 2004. Introduction to Nanoscale Science & Technology, Kluwer Academic Publishers.

Electronic Transport at Nanoscale -- Appl. Phys. 612 -- 3 + 0 CH

Course Objective:

This provides knowledge to understand the mechanism of electronic transport at nanoscale taking advantage of the properties of matter that are distinctly different from macroscopic properties.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Understand general concepts related to the electronic transport at Nanoscale.
- Gain a thorough understanding of how and why electronic transport is different at nanoscale in comparison with macroscale.
- Learn new concepts of heat conduction with a unique perspective at nanoscale.

Course Outline:

There is a plenty of room at the bottom, Classical definition of temperature and heat, macroscopic theory of heat transfer: conduction, convection, radiation, energy balance, local equilibrium, Macroscopic theory of heat carriers and their transport, micro to nanoscale transport phenomenon: classical size effect, quantum size effect, ballistic transport phenomenon. Materials waves and energy quantization, Energy states in solids, Particle description of transport processes: classical laws, Boltzmann equations, carrier scattering, classical size effects: electrical transport in thin films, phonon heat conduction in thin films, current flow in heterojunctions, electron transport across interfaces: thermionic emission, ballistic transport, energy conversion in nanostructures, thermoelectric devices, solar cells and thermophotovoltaic power conversion, liquids and interfaces, forces and potentials between particles and surfaces, size effects, phase transition.

Books Recommended:

1. Massimo F Bertino. 2022. Introduction to Nanotechnology. World Scientist.
2. Changzheng Wu. 2017. Inorganic Two-dimensional Nanomaterials: Fundamental Understanding. Characterizations and Energy Applications. First edition. Royal Society of Chemistry.
3. S.M. Lindsay, 2009. Introduction to nanoscience. Cambridge University Press.
4. S. Datta. 2005. Quantum transport: atom to transistor. Cambridge University Press.
5. S. Datta, 1995. Electronic Transport in Mesoscopic Systems. Cambridge.

Embedded System -- Appl. Phys. 613 -- 2 + 1 CH

Course Objective:
This course provides an in-depth understanding of embedded systems, focusing on both hardware and software aspects. It covers the design, implementation, and testing of embedded systems, with practical lab sessions to reinforce theoretical concepts.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Understand the architecture and components of embedded systems.
- Develop embedded software for real-time applications using programming languages like C.
- Interface microcontrollers with various sensors and actuators.

Course Outline:
Introduction to Embedded Systems: Definition, applications, and characteristics.
Embedded Processors: Microcontrollers, microprocessors, and DSPs.
Hardware-Software Co-Design: System on Chip (SoC), hardware-software partitioning.
Real-Time Operating Systems (RTOS): Concepts, task scheduling, and synchronization.
Embedded Software Development: Programming languages, debugging, and testing.
Interfacing and Communication: Sensors, actuators, communication protocols (I2C, SPI, UART).
Power Management: Power supply design, low-power techniques.
Case Studies and Applications: Consumer electronics, automotive systems, medical devices.

List of Experiments:

1. Introduction to Embedded Development Tools.
2. Programming Microcontrollers.
3. Interfacing Sensors and Actuators.
4. Real-Time Operating System Implementation.
5. Communication Protocols.
6. Power Management Techniques.
7. Embedded System Design Project.

Books Recommended:

1. Lawrence J Henschen, Julia C Lee. 2024. Embedded Systems Design: Methodologies and Issues. 1st Edition. Northwestern Engineering.
2. Daniel W Lewis. 2022. Fundamentals of Embedded Software with the ARM Cortex-M Microcontroller. 5th Edition. Prentice Hall.
3. Tammy Noergaard. 2022. Embedded Systems Architecture: A Comprehensive Guide. 2nd Edition. Newnes Publishing.
4. David Kleidermacher, Mike Kleidermacher. 2022. Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development. 2nd Edition. Elsevier.
5. Yifeng Zhu. 2017. Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C. 3rd Edition. E-Man Press LLC.

Instrumentation -- Appl. Phys. 614 -- 3 + 0 CH

Course Objective:
This course provides an understanding of static and dynamic characteristics used to measure and control the field parameters to increase safety and efficiency of the process. Students will learn basic Biophysics, Biomedical and Electronic instrument.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Understand mechanical and electrical aspects of instruments used to control the dynamics of processes.
- Demonstrate knowledge of commonly used process measurement devices, control methods and strategies, and the proper selection, identification, design, installation and operation of instrumentation.
- Demonstrate the knowledge and ability to develop, construct, and functionally check a process control loop.

Course Outline:
Measurement Principles, Noise Sources, Detection and Noise Removal, Quality Control: Definition and purpose of Instruments, Data analysis, Data presentation (graphing techniques), Curve fitting, Type of Errors, Estimation of Errors using Statistical techniques.
Measurement System: Block Diagram of Functional Elements of a typical Instrument. Model relating Input and Output. Effect of interfacing inputs on outputs and its correction methods.
Generalized Performance Evaluation of Instruments: STATIC: Sensitivity, Linearity, Range, Resolution, Hysteresis Threshold and Dead Span. Calibration.
Dynamic: Design Criteria, Mathematical Modeling, Determination of Parameters by applying Step, Ramp, Impulse and Sinusoidal wavelet inputs to models. Experimental methods of parameters evaluation.
Noise: Basic definition, Intrinsic noises, Extrinsic noise coupling such as Conductive, Capacitive, Magnetic and Electromagnetic. Noise protection methods such as Shielding and Grounding. Safety Grounding and Signal Grounding. Noise in Digital Systems.
Signal Recovery Techniques: Spectral contents of Noise, Statistical Methods of describing stochastic signals. Elimination of Noise by Cross Correlation, Autocorrelation, Examples of use of these techniques in instruments such as Lock-In Amplifier and Frequency Response Amplifier (FRA).
Biomedical Instrumentation: basic Biophysics: Flux Effluence, Drift and Diffusion of Particles, Brownian movement, Cells, Membrane, Nernst Equation, Axon and Mussels. Electrical Properties of Biological systems. Action potential. ECG and EEG signals.
Radiation Effects on Biological systems and Related Instrumentation: Sonic (Ultrasounds), RF (MRI) and Heating, Infrared (Diathermy), Optical (Laser surgery), Ultraviolet (Diathermy), X-rays (general X-ray, CT Scanning).
Clinical Instrumentation: Biological Signal detection, Electrodes and Transducers. ECG machine construction. PH measuring system, Photometers, Colorimeters, Blood Cell Counters.

Books Recommended:

1. A.K. Sawhney. 2021. A Course in electrical and electronic measurements and instrumentation. Dhanpat Rai & Co. Pvt, Ltd.
2. Curtis Johnson. 2005. Process Control Instrumentation Technology. 8th Ed. Prentice Hall.
3. John P. Bentley. 2005. Principles of Measurement Systems. 4th Ed. Pearson.
4. Patrick H. Garrett. 2000. Advanced Instrumentation and Computer I/O Design. Wiley-IEEE Press.
5. John G. Webster. 1997. Medical Instrumentation: Application and Design. 3rd Ed. Wiley.

Data Communication & Networking -- Appl. Phys. 615 -- 3 + 0 CH

Course Objective:

Introduce the fundamentals of data communication and network protocols, focusing on the architecture, functions, and performance of computer networks.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Understand and explain the basic concepts of data communication and networking.
- Analyze different data communication models, transmission and switching techniques.
- Analyze data communication system performance and troubleshoot common networking and security problems

Course Outline:

Introduction to Data Communication: Basic terminology and a simple data communication model. Signals, Types of Signals, Types of Signal Impairment, Protocols, Architectures, Types of Networks, Network Performance Criteria.

OSI and TCP/IP Models: Protocol Architecture. Overview of OSI model and TCP/IP protocol suite. Standard comparison of the two communication models.

Data Transmission Methods and Physical Layer: Analog Data Transmission (Analog-to-Analog Transmission, Digital-to-Analog Transmission), Digital Data Transmission (Analog-to-Digital Transmission, Digital-to-Digital Transmission) techniques and supported media (e.g., copper cables, fiber optics, wireless). Asynchronous and Synchronous transmission. Signal processing and modulation techniques (Analog and Digital modulation techniques). Multiplexing (FDM, TDM).

Data encoding and compression: Signal encoding and decoding, shift keying techniques.

Error detection and correction at Data Link Layer: Framing, Error Control, Error Detection and Correction techniques (CRC, Checksum). Two Sub layers DLC and MAC. Two DLC protocols. Random Access and Controlled Access, MAC addresses and protocols, ARP. Frame Relays

Local Area Networks and LAN Technologies: Local Area Network Technology, LANs Architecture, Topologies, LANs systems (Ethernet, Wi-Fi, Bluetooth), Connecting Devices and VLANs.

Wide Area Networks and WAN Technologies: Telephone networks (components, signaling, LATAs, Dial-up service, DSL), Cable networks, Cellular networks, Satellite networks.

Network Layer and Data Transfer: Services (Packetizing, Routing, Error control, Flow control, Congestion control, Security). Switching (Circuit switching, Packet switching, Virtual-circuit switching). Soft switch architecture, Routing in switched Networks, Internet Protocol (IPv4, IPv6), Addressing in IP, ICMP (ICMPv4, ICMPv6).

Network Layer and Routing: Routing Algorithms, Unicast Routing Protocols, Multicast Routing Protocols, RIP, OSPF, BGP, IGMP, PIM.

Transport Layer: Transport layer services (Process-to-process communication, Port numbers, Encapsulation, Decapsulation, Transport layer Protocols (UDP, TCP, SCTP).

Application Layer: Services, Paradigms (Client/Server, Peer-to-Peer). P2P networks and protocol. Standard Applications (HTTP, FTP, e-mail, TELNET, DNS. Multimedia communication protocols (RTP, RTCP, SIP etc)

Books Recommended:

1. Behrouz A. Forouzan, 2022, Data Communications and Networking, 6th Edition, McGraw-Hill Education.
2. Wendell Odom. 2021. Introduction to Networking. 1st Edition. Pearson IT Certification.
3. Jeffrey S Beasley, Piyasat Nilkaew. 2021. Networking Essentials. 5th Edition. Pearson.
4. William Stallings. 2020. Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud. 1st Edition. Addison-Wesley.
5. James Kurose and Keith Ross, 2016, Computer Networking: A Top-Down Approach, 7th Edition, Pearson Ed.

Optical Communication -- Appl. Phys. 616 -- 2 + 1 CH

Course Objective:
Study optical communication systems, focusing on lightwave technology, fiber optics, and their applications in high-speed data transmission.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Understand the fundamental principles of optical communication and Optical Fiber Technology.
- Analyze the performance of Optical Fiber Systems.
- Design, Implement and Troubleshoot Optical Communication Systems.

Course Outline:
Introduction to Optical Communication: Electromagnetic spectrum and light propagation, Basic components of an optical communication system (light source, fiber optic cable, photodetector), Advantages of optical fiber over traditional copper cables.
Optical Fiber: Types of optical fibers (single-mode, multimode), Fiber optic cable structure, Optical fiber losses and dispersion, Fiber optic connectors and splices.
Light Sources and Detectors: Light-emitting diodes (LEDs), Laser diodes, Photodetectors (photodiodes, PIN diodes, APDs)
Optical Modulation and Demodulation: Intensity modulation and direct detection (IM-DD), Coherent detection techniques, Modulation formats (On-Off Keying, Phase-Shift Keying, Frequency-Shift Keying)
Optical Networks: Wavelength Division Multiplexing (WDM),Dense Wavelength Division Multiplexing (DWDM), Optical Time Division Multiplexing (OTDM), Optical networks (SONET, SDH, Ethernet).
Optical Amplifiers: Erbium-doped fiber amplifiers (EDFAs), Semiconductor optical amplifiers (SOAs).
Optical Network Design and Management: Network planning and design, Network performance monitoring, Fault management and restoration.

List of Experiments:

1. Comparison of LED and LD diode characteristics.
2. Attenuation of Optical Fiber Links
3. Bandwidth and Fiber Dispersion measurement.
4. Eye diagram for direct output of the PRBS generator
5. Eye diagram for transmission of the LED signal over a 1 meter patchchord.
6. Investigation of variation of fiber length for the LED transmitter- Rise time, 80% pulse width and Jitter.
7. Investigation of variation of fiber length for the LED transmitter- Nose, Q-factor and BER.
8. Investigation of eye diagram for the laser transmitter.
9. Investigation of Q-factor and BER as a function of increasing link length.
10. Investigation of Q-factor and BER as a function of increasing bit rate.

Books Recommended*:*

1. John Gowar. 2023. Optical Communication Systems. 1st Edition. McGraw-Hill Education.
2. Jean-Pierre Fouquet. 2023. Photonic Communication Systems. 1st Edition. Springer.
3. Govind P Agrawal. 2021. Fiber Optic Communication Systems. 5th Edition. Wiley
4. Peter J Winzer, Joseph M Kahn. 2022. Introduction to Optical Communication. 1st Edition. Cambridge University Press.
5. Rajiv Ramaswami, Kumar Sivarajan, Galen Sasaki. 2020. Optical Networks: A Practical Perspective. 4th Edition. Morgan Kaufmann.

Wind and Solar Energy -- Appl. Phys. 617 -- 3 + 0 CH

Course Objective:
Introduce renewable energy systems, focusing on wind and solar power technologies, their design, operation, and role in sustainable energy transition.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Explain the principles of wind and solar energy generation.
- Design and analyze commercial-scale & small-scale wind and solar energy systems.
- Evaluate the environmental impact and economic feasibility of renewable energy solutions.

Course Outline:
Wind Energy Overview, Power from Wind, Wind Resource, Wind Power Developments, Overview of Turbine Technology, Aerodynamics and Power Control, Power theory, Electricity Generation and Integration, Planning an O&M program.
Solar Energy Overview, Solar Resource, Solar irradiation components and their properties, PV and Solar Irradiation, PV design, Units and power characteristics, Grid connection, PV Application. Buildings and other solar applications.

Books Recommended:

1. Serdar Celik. 2023. Sustainable Energy: Engineering Fundamentals and Applications. 1st Edition. Cambridge University Press.
2. Soteris A Kalogirou. 2023. Solar Energy Engineering: Processes and Systems. 3rd Edition. Academic Press.
3. Ibrahim Dincer, Calin Zamfirescu. 2022. Renewable Energy Systems: Fundamentals and Applications. 2nd Edition. Springer.
4. James F Manwell, Jon G McGowan, Anthony L Rogers. 2022. Wind Energy Explained: Theory, Design and Application. 3rd Edition. Wiley.
5. Mukund R. Patel. Wind and Solar Power Systems: Design, Analysis, and Operation. 3rd Edition. 2021. CRC Press.

Tidal and Hydro Energy -- Appl. Phys. 618 -- 3 + 0 CH

Course Objective:
Explore tidal and hydroelectric energy systems, covering resource assessment, system design, and environmental impacts, with an emphasis on sustainable power generation.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Understand the principles of tidal and hydroelectric energy generation.
- Design and assess small-scale hydro and tidal energy systems.
- Evaluate the economic and environmental impacts of hydroelectric and tidal power projects.

Course Outline:
Overview of concepts, technologies, management and the control of tidal energy systems and tidal power plants. Fundamentals of tidal energy, including the structure of tidal currents and turbulence. Technology, principles, components, operation, and a performance assessment of each component. Recent research advances and future trends in tidal energy.
Introduction to hydro-resource power production. Hydro power in history. Physics of hydrology. Power, head, flowrate. Turbine hydrodynamics; Francis, Kaplan, Pelton, Turgo, cross-flow. System components: generators, governors, penstocks, spillways, valves, gates, trashracks. Large-scale and microhydroelectric systems. Pumped storage.

Books Recommended:

1. Carlos Guedes Soares, Matthew Lewis. 2020. Wave and Tidal Energy. 1st Edition. Wiley.
2. Vaughn Nelson. 2020. Introduction to Renewable Energy. 1st Edition. CRC Press.
3. Vikas Khare, Cheshta Khare, Savita Nema, Prashant Baredar. Tidal Energy Systems: Design, Optimization and Control. 2018. Elsevier.
4. Viktor M. Lyatkher. Tidal Power: Harnessing Energy from Water Currents. 2014. Scrivener Publishing / Wiley.
5. Hermann-Josef Wagner, Jyotirmay Mathur. 2011. Introduction to Hydro Energy Systems: Basics, Technology and Operation. 1st Edition. Springer-Verlag Berlin Heidelberg.

Functional Materials -- Appl. Phys. 620 -- 3 + 0 CH

Course Objective:

This course will provide the intellectual foundation to familarize with, and understand new classes of materials & their functionalities by revealing the detailed chemistry, structure, process-at-interface and properties/function of solid-state, organic, inorganic or hybrid materials.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Gain indepth knowledge of emerging classes of materials and their functionalities.
- Get the knowledge how the material designed and knowledge of a matching material characteristics and their application.

Course Outline:

Classifications of materials, crystal structures and crystal defects, preparation and properties of single crystals and polycrystalline materials, functional glasses, properties of functional glasses and their classification, carbon material: nano-diamonds, fullerene, nanotubes, graphene. Exceptional properties of graphene, applications of graphene, limitations of graphene, materials beyond graphene, Germanene, silicine and their properties, hexagonal boron nitrides (hBN), advantages and limitations of hBNs, Mxenes and their applications, rise of transition metal dichalcogenides (TMDs), unique properties of TMDs, phases and classes of TMDs, binary and ternary TMDs, band gap engineering and phase engineering applications of TMDs, special properties of ternary TMDs, future of 2D TMDs, perovskite materials and their applications.

Books Recommended:

1. Eds. Yogesh Sonvane, Dimple Shah, K.N. Pathak and Lalit Saini. 2022. Functional Materials and Applied Physics. Materials Research Proceedings Volume 22
2. Giannazzo, Filippo, Samuel Lara Avila, Jens Eriksson, and Sushant Sonde. 2019. Integration of 2D Materials for Electronics Applications. MDPI.
3. Rao, Chintamani Nagesa Ramachandra, and Umesh Vasudeo Waghmare. 2017. eds. 2D inorganic materials beyond graphene. World Scientific.
4. Tiwari, Ashutosh, and Mikael Syväjärvi. 2016. eds. Advanced 2D materials. John Wiley & Sons.
5. Cahangirov, Seymur, Hasan Sahin, Guy Le Lay, and Angel Rubio. 2016. Introduction to the Physics of Silicene and other 2D Materials. Vol. 930. Springer.

Nano Electronics Devices -- Appl. Phys. 621 -- 3 + 0 CH

Course Objective:

It provides an introduction of the electronic. It provides concepts of Ballistic and non-ballistic mechanism. Additionally, it makes a clear distinction between the working of electronic devices at bulk and nano scale.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Gain in-depth understanding related to the working of electronic devices at nano-scale level.
- Understand electronic devices at the atomic scale to utilize small-scale 'quantum' characteristics of nature.
- Develop the understanding about how Ballistic transport can completely change our traditional understanding of electronic devices.

Course Outline:

Overview of nano devices, The quantum particle, Two terminal quantum devices, Current flow in quantum dots, Quantum wires, Scattering and ballistic transport, Landauer Formula, Field Effect Transistors, Molecular FETs, FET switching, Quantum capacitance in FET, Zero charging limit in FETs, Strong charging limit in FETs, Ballistic quantum wire FETs, Ballistic quantum wire FET current voltage characteristics, Ballistic quantum well FETs, MOSFETs, Ballistic MOSFETs, Comparison of ballistic and non-ballistic MOSFETs.

Books Recommended:

1. Angsuman Sarkar, Chandan Kumar Sarkar, Arezki Benfdila. 2023. Nanoelectronics: Physics, Materials and devices. Elsevier.
2. B S Murthy, P Shankar, Baldev Raj, B B Rath and James Murday. 2012. Text book of Nanoscience and Nanotechnology - Universities Press.
3. Chen, Gang. 2005. *Na*noscale Energy Transport and Conversion: A Parallel Treatment of Electrons, Molecules, Phonons, and Photons. Oxford University Press.
4. Hari Singh Nalwa. 2002. Nanostructured Materials and Nanotechnology. Concise Edition. Academic Press.
5. Griffiths, D. J. 1994. "Quantum Mechanics." In Introduction to Quantum Mechanics. Prentice Hall.
6. Kittel, C., and H. Kroemer. 1980. "Thermal Physics." In Thermal Physics. 2nd edition. Freeman and Company.

Artificial Intelligence & Machine Learning -- Appl. Phys. 622 -- 3 + 0 CH

Course Objective

This course provides undergraduate students with a comprehensive introduction to AI and ML principles, with an emphasis on applications in electronics and engineering. Students will learn key machine learning algorithms, deep learning basics, and practical implementations to solve real-world problems in electronics.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Understand and apply fundamental AI/ML algorithms to solve electronics-related problems.
- Develop skills in data collection, pre-processing, and feature extraction from electronics components and systems.
- Implement AI/ML models using Python to analyse, classify, and make predictions on electronics data.

Course Outline:

Introduction to AI & ML basics, overview of AI and ML, types of machine learning, applications in Electronics. Mathematics and statistics for machine learning, linear algebra, probability and statistics, optimization techniques.
Supervised learning algorithms, linear and logistic regression, support vector machines (SVM), decision trees and random forests, K-nearest neighbors (KNN). Unsupervised learning algorithms, clustering techniques, principal component analysis (PCA), anomaly detection. Neural networks and deep learning, artificial neural networks (ANN), convolutional neural networks (CNNs), recurrent neural networks (RNNs).
Applied ML for electronics, signal processing with ML, predictive maintenance, data acquisition and preprocessing. Model evaluation and optimization techniques, cross-validation and hyperparameter tuning, regularization methods
Practical implementations with Python, programming libraries, project-based learning, case studies.

Books Recommended:

1. Oliver Theobald. 2023. Machine Learning for Absolute Beginners. 4th Edition. Scatterplot Press.
2. Yuxi Liu. 2023. Python Machine Learning by Example". 1st Edition. Packt Publishing.
3. Melanie Mitchell. 2020. Artificial Intelligence: A Guide for Thinking Humans. 1st Edition. Farrar, Straus and Giroux.
4. Aurélien Géron. 219. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow. 2nd Edition. O'Reilly Media.
5. Andreas Müller, Sarah Guido. 2016. Introduction to Machine Learning with Python. 1st Edition. O'Reilly Media.

Internet-of-Things (IoT) -- Appl. Phys. 623 -- 2 + 1 CH

Course Objective:
Equip students with foundational knowledge of IoT concepts, including network protocols, sensor integration, and data processing, to build connected systems for smart applications in various domains like health, agriculture, and smart cities.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Describe IoT architecture and protocols for connectivity and data transfer.
- Develop IoT applications using sensors, microcontrollers, and communication modules.
- Analyze security and privacy challenges in IoT environments.

Course Outline:
Introduction to IoT: definition and characteristics of IoT; IoT architecture; overview of embedded systems in IoT; communication protocols including MQTT, HTTP, Bluetooth, Zigbee; IoT use cases in electronics (smart homes, wearables and industrial automation).
Sensors, Actuators, and IoT Hardware: common sensors including temperature, humidity, pressure, motion, etc.; actuators and interfacing with sensors; overview of ESP8266, ESP32, Raspberry Pi; connecting sensors to microcontrollers; power management and low-power devices for IoT.
IoT Communication and Networking: IoT data communication; cloud computing and IoT; IoT security concerns; IoT platforms like Google Cloud IoT, AWS IoT, Azure IoT Hub.

List of Experiments:

1. Basics of Arduino and interfacing sensors.
2. Send IoT data to the cloud.
3. Configuration of Raspberry Pi for IoT applications.
4. Edge computing in IoT.
5. Visualize real-time IoT sensor data
6. Predictive maintenance system using IoT data.
7. Regression techniques to IoT data.

Books Recommended:

1. Peter Waher. 2023. Mastering Internet of Things. 2nd Edition. Packt Publishing.
2. Olivier Hersent, David Boswarthick, Omar Elloumi. 2023. The Internet of Things: Key Applications and Protocols. 2nd Edition. Wiley.
3. Aditi Paul, S Sinha. 2023. Internet of Things in Modern Computing: Theory and Applications. 1st Edition. Routledge.
4. Rajkumar Buyya, Amir V Dastjerdi. Internet of Things (IoT): Architectures, Protocols and Applications. 1st Edition. 2023. Morgan Kaufmann.
5. Perry Lea. IoT and Edge Computing. 2nd Ed. 2022. Packt Publishing.

Wireless Communications -- Appl. Phys. 624 -- 3 + 0 CH

Course Objective:
Cover the essentials of wireless communication technologies, emphasizing cellular networks, Wi-Fi, and emerging standards for mobile and IoT applications.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Understand the fundamental principles of wireless communication systems and their standards.
- Analyze the performance of wireless systems in different propagation environments.
- Evaluate the impact of emerging wireless technologies.

Course Outline:
Fundamentals of Wireless Communication: Electromagnetic wave propagation, Channel models (fading, interference, noise), Channel Capacity, Link budget analysis, Modulation and demodulation techniques. Trouble with Wireless Analog and Digital Data Transmission. Multiplexing and Switching techniques.
Cellular and Mobile Communication Systems: Cellular network architecture, Frequency reuse and cell planning, Handoff techniques, Mobile radio propagation. Antenna and propagation modes. Signal Encoding techniques. Mobile IP and Wireless Access Protocol.
Wireless LANs (WLANs): IEEE 802.11 standards, Wireless LAN technologies (Wi-Fi, Wi-Fi Direct), Network security (WEP, WPA, WPA2).
Wireless Wide Area Networks (WWANs): Cellular networks (GSM, GPRS, EDGE, UMTS, LTE, 5G), Satellite communication systems.
Wireless Sensor Networks: Sensor node architecture, Network topology and routing protocols, Energy-efficient communication techniques.
Cognitive Radio Networks: Spectrum sensing, Dynamic spectrum access, Cognitive radio protocols.

Books Recommended:

1. Theodore S Rappaport. 2024. Wireless Communications: Principles and Practice. 2nd Edition. Cambridge University Press.
2. Andrea Goldsmith. 2023. Wireless Communications: From Fundamentals to Beyond 5G. 3rd Edition. Wiley-IEEE Press.
3. Savo Glisic. 2023. Advanced Wireless Communications and Internet: Future Evolving Technologies. 2nd Edition. Wiley.
4. Theodore S Rappaport, Robert W Heath, Murdock. 2023. Millimeter Wave Wireless Communications. 1st Edition. Pearson.
5. Krishnamurthy Raghunandan. 2023. Introduction to Wireless Communications and Networks: A Practical Perspective. 1st Edition. Springer.

Broadband Communication -- Appl. Phys. 625 -- 3 + 0 CH

Course Objective:

Develop an understanding of broadband communication technologies, including DSL, cable, and fiber-optic systems, for high-speed data transfer.

Course Learning Outcomes:

Upon completing this course, students will be able to:

- Understand the principles of broadband communication technologies.
- Analyze the performance of different broadband networks.
- Evaluate the impact of emerging technologies on broadband networks.

Course Outline:

Broadband Network Architectures: Internet Protocol (IP) networks, X.25 and Frame Relays, Asynchronous Transfer Mode (ATM) networks, Broadband Integrated Services Digital Network (B-ISDN), Fiber-to-the-X (FTTX) technologies (FTTH, FTTC, FTTB)

High-Speed Transmission Technologies: Digital Subscriber Line (DSL) technologies (ADSL, VDSL), Cable modems, PONs, Fiber-optic communication systems, SONET, Wireless technologies (Wi-Fi, WiMAX, 5G)

Network Protocols: TCP/IP protocol suite for BBN, Quality of Service (QoS) mechanisms, Routing protocols (OSPF, RIP), Network security protocols (SSL, TLS, VPN)

Network Performance and Management: Network performance metrics (throughput, latency, jitter), Fault Tolerance Analysis, Network monitoring and troubleshooting tools, Network management protocols (SNMP, RMON)

Emerging Technologies: Software-Defined Networking (SDN), Network Function Virtualization (NFV), Personal Communication Services (PCS), Internet of Things (IoT)

Books Recommended:

1. Abid A Minhas. 2023. Broadband Communications Networks: Recent Advances and Lessons Learned. 1st Edition. Springer.
2. Benny Mandler, James D Brusey, Edward W Johnston. 2023. Broadband Communications, Computing, and Control for Ubiquitous Intelligent Systems. 1st Edition. CRC Press.
3. Thomas M Chen. 2022. Next-Generation Broadband Communication Networks. 2nd Edition. Wiley.
4. Shuji Hirakawa. 2022. Fundamentals of Broadband Optical and Wireless Networks. 1st Edition. Wiley.
5. Broadband Communication System by James canard, Aurback publications, 2018.

Smart Grid Technology -- Appl. Phys. 626 -- 3 + 0 CH

Course Objective:
Introduce students to smart grid concepts, including advanced metering, grid communication, and demand response, to support efficient and reliable power distribution.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Describe the architecture and components of smart grids.
- Analyze the role of automation, data management, and communication in smart grids.
- Apply smart grid technologies to improve grid reliability and efficiency.

Course Outline:
Issues unique to connecting renewable energy generation to the grid. Micro grids, Stability, transient and harmonic effects, Interconnect agreements and requirements, Standard development, SCADA and smart grid concepts, Systems optimization.
Modern and advanced concept of smart grid technology, Fundamental concepts of different architectures, control issues, communication challenges, measurement, stability, power quality and mitigation, protection, and power electronic aspects of smart grid system. Recent and developing topics like smart meter impact, remote data monitoring, communication protocols, cyber security, artificial intelligence, big data and IoT.

Books Recommended:

1. Atif Iqbal, Sanjeet Dwivedi. 2023. Modern Power Systems and Smart Grids. 1st Edition. Springer.
2. Qiang Lu, Ying Chen, Xuemin Zhang. 2022. Smart Power Systems and Smart Grids. 1st Edition. De Gruyter.
3. Stuart Borlase. 2022. Smart Grids: Advanced Technologies and Solutions. 3rd Edition. CRC Press.
4. A Monti, C Muscas. 2021. Smart Grid Fundamentals. 2nd Edition. Wiley.
5. Trevor Letcher. 2021. Future Energy: Smart Grids. 2nd Edition. Elsevier.

Biofuel and Biomass Energy -- Appl. Phys. 627 -- 3 + 0 CH

Course Objective:
Provide a comprehensive overview of bioenergy resources, focusing on biofuel and biomass conversion processes for sustainable energy production.

Course Learning Outcomes:
Upon completing this course, students will be able to:

- Describe biomass sources and biofuel production methods.
- Analyze energy conversion processes for biofuels, such as combustion and gasification.
- Evaluate the sustainability and scalability of biofuel technologies.

Course Outline:
Introduction to power production from biomass resources. Historical uses of biomass resources. Biomass is a solar energy store, forestry and agricultural sources, crop waste. Recycled sources; municipal solid waste, landfill gas. Gaseous fuels, anaerobic digestion, gasification, liquid fuels, fermentation, hydrolysis, transesterification.

Books Recommended:

1. Sergio Capareda. 2023. Introduction to Biomass Energy Conversions. 2nd Edition. CRC Press.
2. Ozcan Konur. 2023. Biofuels: Production and Future Perspectives. 1st Edition. Springer.
3. Jorge Varejao. Biomass. 2022. Bioproducts and Biofuels. 1st Edition. CRC Press.
4. Michael Carus. 2022. Biomass and Biofuels: Advanced Biorefineries for Sustainable Production. 1st Edition. Elsevier.
5. Frank Muschal. Bio-fuels. 2007. Cherry Lake Publishing.
