UNIVERSITY OF KERALA

DEPARTMENT OF OPTOELECTRONICS

Electronics and Photonics (Minor)
for B.Sc. Hons.

SYLLABUS

Preamble

This four-year undergraduate journey embarks upon a transformative exploration of the principles, technologies, and innovations that shape the modern world of electronics and photonics. Rooted in a commitment to academic excellence and innovation, our program is designed to empower students with the knowledge, skills, and experiences necessary to become leaders and innovators in the dynamic fields of electronics and photonics. Through a rigorous curriculum, hands-on learning experiences, and collaborative research opportunities, we foster a culture of exploration, discovery, and creativity that prepares students for success in a rapidly evolving technological landscape.

At the core of our program is a comprehensive study, encompassing fundamental principles, advanced theories, and cutting-edge applications. From semiconductor devices and integrated circuits to fiber optic sensors and robotics, students delve deep into the intricate workings of electronic and photonic systems, gaining a nuanced understanding of their underlying principles and practical applications.

Our interdisciplinary approach encourages students to explore the intersections between different fields of science and engineering, fostering innovation and cross-pollination of ideas. Through collaborative projects, industry partnerships, and experiential learning opportunities, students engage in real-world problem-solving, innovation, and entrepreneurship, preparing them to address the grand challenges of the 21st century.

This syllabus provides a comprehensive overview of the core courses and elective courses typically included in a four-year Electronics and Photonics (Minor) program for B.Sc. Hons. It aims to prepare students for careers in various fields related to electronics, including research, development, manufacturing, and academia. The semester-wise distribution of the courses is given. The Programme Outcomes, Programme Specific Outcomes and Course Outcomes are described.

Programme Outcomes (POs)

PO1	Apply analytical and critical thinking skills to solve complex problems in electronics, design circuits, and troubleshoot electronic systems.
PO2	Demonstrate ability to design, simulate and implement electronic circuits and systems to meet specified performance requirements and constraints.
PO3	Understand the ethical and professional responsibilities associated with electronic circuits and design, including considerations of safety, sustainability, and societal impact.
PO4	Effectively communicate technical content through written reports/design documents, and presentations.
PO5	Recognize the importance of continued learning and professional development, staying abreast of advancements in electronics technology.

Programme Specific Outcomes (PSOs)

PSO1	Understand the principles of analog electronic circuits, and be able to design, analyze, and optimize analog circuits for specific applications.
PSO2	Develop skills in digital logic design, microprocessor architecture, assembly language programming, and interfacing digital systems with peripheral devices which are in tune with current technology and adaptable for future changes.
PSO3	Acquire knowledge of signal processing techniques, such as filtering, modulation, demodulation, spectral analysis, and digital signal processing algorithms, and apply them to real-world signals.
PSO4	Learn about communication systems theory, modulation techniques, transmission media, noise considerations, and design and analyze communication systems for various applications
PSO5	Act as part of the electronic design industry to become a leader in indigenous product development.

CHAPTER-I

GENERAL SCHEME OF THE SYLLABI

1.1 Theory Courses:

There are seven core courses and two core practical (mandatory) courses in semesters I-VII and eight optionals with two practicals in semesters I-VIII in a four-year Electronics and Photonics (Minor) program for B.Sc. Hons. The distribution of theory courses is as follows. There are seven core courses from semesters I-VII. Semesters I - VII have one core course each. There are eight optionals from semesters I-VIII.

1.2 Practical:

Semester VII will have two core courses on laboratory practicals. Semester III will have two optional practicals. A minimum of 10 experiments should be done and recorded in each semester. The practical examinations will be conducted at the respective examination centers by two examiners (one internal and one external appointed by the University) at the end of each semester.

1.3 Course Structure of Program:

The detailed structure of the Core courses common to all students of the program is given in Table 1.1

Table 1.1: Course Structure of B.Sc. Hons. in Electronics and Photonics

Sem. No.	Course Code	Name of the Course	Credits	Total Credit per Semester
Core Courses (CC)				
I	UK1MNEDOP101	Basic Electronics	4	4
II	UK2MNEDOP101	Analog and Digital Electronics	4	4
III	UK3MNEDOP201	Optics and Electromagnetic Theory	4	4
IV	UK4MNEDOP201	Semiconductor Optoelectronics	4	4
V	UK5MNEDOP301	Fiber Optics and Waveguides	4	4
VI	UK6MNEDOP301	Electronic and Optical Communication	4	4
VII	UK7MNEDOP401	Signals and Systems	4	4
	UK7MNEDOP402	Optics and Optoelectronics - Practical	2	2
	UK7MNEDOP403	Communication - Practical	2	2
Optionals				
I	UK1MNEDOP102	Solar Photovoltaics	4	4
II	UK2MNEDOP102	Nanophotonics	4	4
III	UK3MNEDOP202	Basic Electronics - Practical	2	2
	UK3MNEDOP203	Analog and Digital Electronics - Practical	2	2
IV	UK4MNEDOP202	Fiber Optic Sensors and Applications	4	8
	UK4MNEDOP203	Optical Instrumentation	4	
V	UK5MNEDOP302	Micro-Electro-Mechanical Systems	4	4

VI	UK6MNEDOP302	Nanoelectronics	4	4
VII	UK7MNEDOP404	Image Processing	4	4
VIII	UK8MNEDOP401	Laser Remote Sensing	4	4

CHAPTER - II

ASSESSMENT AND EVALUATION

2.1 Examinations

The evaluation of each course shall contain two parts such as Internal or Continuous Assessment (CA) and External or End-Semester Assessment (ESA).

2.2 Internal or Continuous Assessment (CA)

Internal evaluation is to be done by continuous comprehensive assessments. The internal assessment should be fair and transparent. Continuous Assessment (CA) has a weightage of 40 marks. Continuous Assessment (CA) has four components:- (i) Mid Semester examination of 20 marks, (ii) Attendance of 5 marks, (iii) Seminar of 5 marks and (iv) Any of the innovative continuous assessment methods of 10 marks respectively. The evaluation of the components should be published and acknowledged by students. All documents of internal assessments are to be kept in the institution for 2 years and shall be made available for verification by the university. The responsibility of evaluating the internal assessment is vested on the teacher(s) who teach the course. The test papers should be in the same model as the end-semester examination question paper. The duration and the number of questions in the paper may be adjusted judiciously for the sake of convenience. There shall be no separate minimum grade point for internal evaluation of Theory and Practical. No minimum is required for internal evaluation for a pass, but a minimum is required for a pass in an external evaluation.

2.2.1 Attendance, Assignment, and Seminar

Students with attendance less than 75% in a course are not eligible to attend an external examination of that course. The performance of students in the seminar and assignment should also be documented.

2.2.3 Innovative Continuous Assessment

The component of innovative continuous assessment can be viva voce based on topics covered in each course during the semesters and awareness of related current and advanced topics.

2.2.4 General Instructions

i. The assignments/seminars/test papers are to be conducted at regular intervals. These should be marked and promptly returned to the students.

ii. One teacher appointed by the Head of the Department will act as a coordinator for consolidating grade sheets for internal evaluation in the department in the format supplied by the University. The consolidated grade sheets are to be published on the department notice board one week before the closing of the classes for end-semester examinations. The grade sheet should be signed by the coordinator and counter-signed by the Head of the Department.

iii. The consolidated grades in a specific format supplied by the university are to be kept in the college for future reference. The consolidated grades in each course should be uploaded to the University Portal at the end of each semester as directed by the University.

iv. A candidate who fails to register for the examination in a particular semester is not eligible to continue in the subsequent semester.

2.3 External or End Semester Assessment (ESA)

The external examination of all semesters shall be conducted by the University at the close of each semester.

2.3.1 Question Paper Pattern for Theory Courses

All the theory question papers are of three-hour duration. All question papers will have two/three parts.

2.3.2 Practical Examinations

Practical Evaluation: The practical examinations are conducted immediately after the semester theory examinations. All practical examinations will be of three hours duration. One examiner from the panel of examiners of the University will be deputed by the board chairman to each of the examination centers for the fair and transparent conduct of examinations. Practical examination is conducted in batches having a maximum of eight students. The board has the right to decide on the components of practical and the respective weights.

2.3.3 Reappearance/Improvement:

For reappearance/ improvement as per university rules, students can appear along with the next regular batch of students of their particular semester. A maximum of two chances will be given for each failed paper. Only those papers in which the candidate have failed need to be repeated.

CHAPTER III

SYLLABUS

Course Outcomes

Semester: 1	Course Code: UK1MNEDOP101
Course Title: Basic Electronics I	**Credits: 4**

Prerequisite: Basic knowledge of electricity and electrical devices.

Objective: To provide students with a solid foundation in basic electronics principles and practical skills, enabling them to understand, analyse, design, and troubleshoot electronic circuits and systems effectively.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Understand and explain the working principles and waveform characteristics of HWR and FWR.
CO2	Analyze transistor biasing circuits including fixed bias, voltage divider bias, and emitter bias.
CO3	Explain the construction and operation of JFET, MOSFET and UJT.
CO4	Interpret the current-voltage characteristics of JFETs and MOSFETs.
CO5	Perform DC and AC load line analysis for CE amplifiers.
CO6	Understand the Barkhausen criteria for oscillation and analyze phase shift, Colpitts, and Hartley oscillators.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Understand and explain the working principles and waveform characteristics of HWR and FWR.	PSO1	U	C
CO2	Analyze transistor biasing circuits including fixed bias, voltage divider bias, and emitter bias.	PO1, PSO1	U and Ap	C, P and M
CO3	Explain the construction and operation of JFET, MOSFET and UJT.	PO1, PO2	Cr, E and An	P and M
CO4	Interpret the current-voltage characteristics of JFETs and MOSFETs.	PO2, PSO1	Ap and An	P and M

CO5	Perform DC and AC load line analysis for CE amplifiers.	PO2, PSO1	Ap and An	P and M
CO6	Understand the Barkhausen criteria for oscillation and analyze phase shift, Colpitts, and Hartley oscillators.	PO2, PSO1	Ap and An	P and M

(**CL- Cognitive Level**: R-Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (15 Hrs)

Network Theorems: Network Analysis, Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Maximum Power Transfer Theorem. AC circuit analysis using Network theorems.

Diode Circuits: pn junction- diode equation, diode circuits- rectifiers: HWR, FWR (centre tapped and bridge), ripple factor & efficiency, clipping and clamping circuits. Zener diode regulator circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator. Filters: types- LC, RC, LCR

Module II (15 Hrs)

Bipolar Junction Transistor: Transistor action-amplifier circuits-CE, CB, CC -Load line analysis- stability factor, Hybrid parameters., biasing circuits-Fixed bias without and with R_E, emitter follower, voltage divider bias and emitter bias (+VCC and –VEE bias).

Amplifier: BJT amplifier (CE), dc and ac load line analysis, hybrid model of CE configuration, Quantitative study of the frequency response of a CE amplifier, Effect on gain and bandwidth for Cascaded CE amplifiers (RC coupled)

Module III (15 Hrs)

Feedback Amplifiers: Concept of feedback, negative and positive feedback, advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, gain, input and output impedances.

Power Amplifiers: Difference between voltage and power amplifier, classification of power amplifiers, Class A, Class B, Class C and their comparisons.

Module IV (15 Hrs)

Oscillators: Barkhausen criteria for oscillations, Study of phase shift oscillator, Colpitts oscillator and Hartley oscillator.

Special Devices: FET (both N channel and P Channel) - FET amplifier- Theory and construction- MOSFET, UJT, UJT relaxation oscillator, Klystron, Variac- principle and Characteristic curves.

References:

1. S. A. Nasar, Electric Circuits, Schaum's outline series, Tata McGraw Hill (2004).
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3. Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004).
4. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill (2005).
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13. Albert Malvino and David Bates, Electronic Principles.
14. K Gopakumar, Introduction to Electronics and Communication, Phasor Books, 2013.
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16. Theraja B. L., A TextBook of Electrical Technology -I, S. Chand & Co, New Delhi, 2013.
17. Bhargava N. N., D C Kulshreshtha and S C Gupta, Basic Electronics & Linear Circuits, TMH, 2013.

Semester: II	Course Code: UK2MNEDOP101
Course Title: Analog and Digital Electronics	**Credits: 4**

Prerequisite: Knowledge in basic electronics.

Objective: To provide students with a comprehensive understanding of operational amplifiers, digital electronics, and microprocessors.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Analyze and design operational amplifier circuits for various applications, including amplifiers, filters, and oscillators.
CO2	Design and implement non-linear op-amp circuits such as comparators, Schmitt triggers, and waveform generators.
CO3	Demonstrate proficiency in binary number systems, logic gates, and Boolean algebra for digital circuit design and analysis.
CO4	Design and implement combinational and sequential circuits using appropriate components and techniques.
CO5	Demonstrate an understanding of microprocessor architecture, instruction set, and programming techniques.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Analyze and design operational amplifier circuits for various applications, including amplifiers, filters, and oscillators.	PO1, PSO1	U, Ap, An	P and M
CO2	Design and implement non-linear op-amp circuits such as comparators, Schmitt triggers, and waveform generators.	PO1, PSO1	An, Ap and Cr	P and M
CO3	Demonstrate proficiency in binary number systems, logic gates, and Boolean algebra for digital circuit design and analysis.	PO2, PSO1	An, Ap and Cr	P and M
CO4	Design and implement combinational and sequential circuits using appropriate components and techniques.	PO2, PSO5	An, Ap and Cr	P and M
CO5	Demonstrate an understanding of microprocessor architecture, instruction set, and programming techniques.	PO1, PSO1	An, Ap and Cr	P and M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (15 Hrs)
Operational amplifiers: Differential Amplifier, Characteristics of ideal op-amp, op-amp architecture, opamp parameters- op- amp circuits-amplifier-mathematical operator-oscillator- waveform generators, Non-Linear Op-amp Circuits: Open Loop Comparator, Polarity Indicator, Schmitt Trigger; astable and monostable circuits, Active filters: LPF and HPF.

Module II (15 Hrs)
Number Systems: Decimal number system - binary number system -conversion of binary number to decimal and decimal number to binary - binary addition andsubtraction-1's complement - 2's complement - binary subtraction using 2's complement

Logic gates and Logic simplification: Logic gates AND, OR, NOT, NAND, NOR and XOR gate - realization of other logic functions using NAND/NOR gates - tri state logic gate – Boolean laws. De Morgan's: De Morgan's theorem – Binary Adders- Half adder,Full adder-Excess-3 code, Excess-3 adder.

Karnaugh Map: Simplification of Boolean equations using Booleanlaws – Two variable map, Three variable map, Four variable map.

Module III (10 Hrs)
Combinational Circuits: Multiplexers, decoders, encoders, buffers, code converters, adder, subtractor.
Sequential Circuits: Latches- Flip-Flops- RS, JK, JK Master Slave, D- clocked sequential circuits- Registers and Counters- .

Module IV (20 Hrs)
Microprocessors: Organisation of Intel 8085 microprocessor, Architecture - Instruction set of 8085, Addressing modes, Timing diagram-Programming of 8085, Architecture of 8086 Microprocessor, Peripheral Devices and their Interfacing: Memory and I/O interfacing,data transfer schemes. Programmable peripheral interface (8255), Programmable DMA controller (8257), Programmable interrupt controller (8259), Programmable communication interface (8251).

References:

1. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, McGraw Hill Book Company 1998.
2. Millman J. and C. Halkias, “Integrated Electronics”, 2/e, TMH, 2010.
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15. R.S. Goankar, Microprocessor Architecture Programming & applications with 8085, 2002, Prentice Hall.
16. B.Ram, Fundamentals of Microprocessors and Micro controllers –Dhanpat rai & sons.

Semester: III	Course Code: UK3MNEDOP201
Course Title: Optics and Electromagnetic Theory	**Credits: 4**

Prerequisite: Basic knowledge about wave phenomena and principles.

Objective: To provide students with a comprehensive understanding of advanced topics in optics, electromagnetism, and wave phenomena.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Explain the principles of interference, including Young's double-slit experiment and thin film interference.
CO2	Analyze diffraction phenomena using Huygens-Fresnel principle and diffraction gratings.
CO3	Describe the polarization of light and its applications, including Malus' law and double refraction in crystals.
CO4	Understand the principles of laser operation and analyze common types of lasers.
CO5	Explain the behavior of electromagnetic fields in matter and analyze Maxwell's equations in various media.
CO6	Apply the concepts learned to solve problems and analyze real-world electromagnetic phenomena

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Explain the principles of interference, including Young's double-slit experiment and thin film interference.	PO1	Ap and An	P and M
CO2	Analyze diffraction phenomena using Huygens-Fresnel principle and diffraction gratings.	PO2	Ap and An	P and M
CO3	Describe the polarization of light and its applications, including Malus' law and double refraction in crystals.	PO2, PSO1	An, Ap and E	P and M
CO4	Understand the principles of laser operation and analyze common types of lasers.	PO2, PSO1	U	F and C

CO5	Explain the behavior of electromagnetic fields in matter and analyze Maxwell's equations in various media.	PO1, PSO1	U, An and Ap	C, P and M
CO6	Apply the concepts learned to solve problems and analyze real-world electromagnetic phenomena	PO1, PSO1	Ap and An	P and M

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Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (20 Hrs)

Interference: Superposition of waves, Concept of coherence, Interference by division of wavefront, Young's double slit, Division of Amplitude, thin film interference, anti-reflecting films, Newton's rings; Michelson interferometer. Holography. (Qualitative)

Diffraction: Huygen Fresnel Principle, Diffraction Integral, Fresnel and Fraunhoffer approximations. Fraunhoffer Diffraction by a single slit, double slit, resolving power of microscopes and telescopes; Diffraction grating: Resolving power and Dispersive power.

Polarization: Linear, circular and elliptical polarization, polarizer-analyzer and Malus' law; Double refraction by crystals, Interference of polarized light, Wave propagation in uniaxial media. Half wave and quarter wave plates. Faraday rotation and electro-optic effect.

Module II (15 Hrs)

Lasers: Black body radiation, Planck's law, Interaction of radiation and matter, spontaneous and induced transitions- Einstein's coefficients, gain coefficient, Coherence – Spatial and Temporal coherence- Line broadening mechanisms- homogenous and inhomogeneous broadened systems. Condition for amplification, laser cavity, Laser oscillation conditions - population inversion - three and four-level systems - rate equations, Optical resonators, Common Lasers- Ruby, CO_2 laser, He-Ne laser, Nd:YAG laser.

Module III (10 Hrs)

Electrostatic fields in matter and Electrodynamics: Time varying fields and Maxwell's equations, Potential formulations- Scalar and Vector Potential, Gauge transformations, boundary conditions, wave equations and their solutions, Poynting theorem, Maxwell's stress tensor. Maxwell's equations in phasor notation. Propagation of Electromagnetic Waves in conducting medium and non-conducting medium.

Module IV (15 Hrs)

Electromagnetic Radiation: Retarded potentials, Lienard-Wiechert potential, Fields of a moving point charge, Electric dipole radiation, Magnetic dipole radiation, Power radiated by point charge inmotion. Radiation reaction, Radiation resistance of a shortdipole, Radiation from quarter wave monopole or half wave dipole.

Antennas: Dipole arrays, Folded Dipole and Yagi-Uda Antenna (VHF). Microwave Antennas: Antenna with parabolic reflectors, Horn antenna. Transmission Lines-Principles-Characteristic impedance, Classification of Transmission lines.

References:

1. Ajoy Ghatak, Optics, Tata McGraw Hill, New Delhi (2005)
2. E. Hecht, Optics, Pearson Education Ltd. (2002)
3. J. Wilson and J. F. B. Hawkes, Optoelectronics: An Introduction, Prentice Hall India (1996)
4. S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson Education (2009)
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13. Microwave Engineering and Applications O.P.Gandhi (Maxwell Macmillan International Edition.)
14. Classical electrodynamics J.D.Jackson (Willey Eastern Ltd., New Delhi, INDIA)
15. Classical Electrodynamics S.P.Puri (Tata McGraw Hill Publishing Co. Ltd., New Delhi, INDIA)
16. Introduction to Electrodynamics David J. Griffith (Prentice Hall of India Pvt. Ltd., New Delhi, INDIA)
17. Electromagnetic Field Theory Fundamentals Bhag Guru (Cambridge Publications)
18. Electromagnetic Field theory and Transmission Lines G.S.N.Raju (Pearson Education, South Asia)

Semester: IV	Course Code: UK4MNEDOP201
Course Title: Semiconductor Optoelectronics	Credits: 4

Prerequisite: Basic knowledge about electronic circuits and devices.

Objective: To provide students with a deep understanding of semiconductor materials and optoelectronic devices.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Analyze the energy band diagram and carrier concentration in semiconductors under different conditions.
CO2	Understand the principles of carrier transport, mobility, and conductivity, and their variations with temperature and doping.
CO3	Explain the operation and characteristics of PN junctions, including the formation of depletion region and built-in potential.
CO4	Describe the electronic properties of compound semiconductors and their applications in optoelectronic devices.
CO5	Analyze the operation and characteristics of various photonic devices such as LEDs, laser diodes, photodetectors, and solar cells.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Analyze the energy band diagram and carrier concentration in semiconductors under different conditions.	PO1	U, An	C and P
CO2	Understand the principles of carrier transport, mobility, and conductivity, and their variations with temperature and doping.	PO1/PSO1	U and E	F, P and C
CO3	Explain the operation and characteristics of PN junctions, including the formation of depletion region and built-in potential.	PO2/PSO1	U, An and Ap	P and M
CO4	Describe the electronic properties of compound semiconductors and their applications in optoelectronic devices.	PO3	An, Cr and Ap	P and M
CO5	Analyze the operation and characteristics of various photonic devices such as LEDs, laser diodes, photodetectors, and solar cells.	PO2/PSO4	U, An and Ap	P and M

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KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (15 Hrs)

Energy Bands in Solids: Energy Band Diagram, Direct and Indirect band gap semiconductors, Effective mass. Semiconductors- Intrinsic and Extrinsic. Carrier Concentration-Fermi-Dirac distribution function, Electron and Hole concentration at equilibrium, Temperature dependence of intrinsic carrier concentration & majority carrier concentration in extrinsic semiconductor, Equilibrium electron hole concentration.

Module II (15 Hrs)

Carrier transport in semiconductors – mobility and conductivity. Variation of mobility with temperature & doping. Constancy of Fermi level at equilibrium. Hall Effect. Quasi Fermi level, Diffusion of charge carriers. Einstein relation. Continuity equation. PN junction under thermal equilibrium, Equilibrium energy band diagram – Distribution of carrier concentration, potential, electric field and charge density.

Module III (15 Hrs)

Optoelectronic materials, compound semiconductors, III-V and II-VI compounds, ZnO, ITO, GaN, direct and indirect band gap, electronic properties of semiconductors, Fermi level, density of states, life time and mobility of carriers, invariance of Fermi level at equilibrium, diffusion, continuity equation, excess carriers, Quasi-Fermi levels. Quantum well lasers, VCSEL, DFB and DBR lasers.

Module IV (15 Hrs)

Photonic Devices: LED- Construction, materials and operation- Blue LED, Laser diodes, Semiconductor injection laser diode. Photodetectors-Photomultiplier tube, Charge Coupled Device. Phototransistors and Photodiodes (p-i-n, avalanche), quantum efficiency and responsivity. Photodetectors, photoconductors and photodiodes, PIN diodes, heterojunction diodes and APDs, photomultiplier tube, Solar cellmaterials and their properties.

References:

1. Amnon Yariv, Optical Electronics, Holt Rine hart & Winston, Philadelphia, 1991
2. Ben G. Streetmann& Sanjay Banerjee, Solid State Electronic Devices, 5thEdn, 2000.
3. Bhattacharya P., Semiconductor Optoelectronic Devices, PHI, New Delhi.1995
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Applications, John Wiley & Sons, England 2006.
6. W.R Fahrner: Nanotechnology & Nanoelectronics, (Springer 2005)
7. M S Tyagi: Introduction to semiconductor materials and devices (Wiley India)
8. D A Neeman: Semiconductor Physics& Devices (Tata Mc-Graw-Hill).

Semester: V	Course Code:UK5MNEDOP301
Course Title: Fiber Optics and Waveguides	Credits: 4

Prerequisite Knowledge in optics and wave propagation.

Objective: To familiarize students with a comprehensive understanding of optical fibers, their characteristics, transmission properties, and associated components.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Explain the principles of total internal reflection and numerical aperture in optical fibers.
CO2	Analyze and compare different types of optical fibers based on their refractive index profiles and modes of propagation.
CO3	Describe the fabrication methods of optical fibers and understand the factors influencing fiber quality.
CO4	Analyze the transmission characteristics of optical fibers, including attenuation, dispersion, and nonlinear effects.
CO5	Identify and describe various passive optical components such as connectors, couplers, and gratings, and understand their applications in optical communication systems.
CO6	Understand the principles and functioning of optical amplifiers and compare different types based on their performance parameters such as gain, noise figure, and bandwidth

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Explain the principles of total internal reflection and numerical aperture in optical fibers.	PSO1	R,U	F, C
CO2	Analyze and compare different types of optical fibers based on their refractive index profiles and modes of propagation.	PSO1	An	C, P
CO3	Describe the fabrication methods of optical fibers and understand the factors influencing fiber quality.	PO3/ PSO2	E	P
CO4	Analyze the transmission characteristics of optical fibers, including attenuation, dispersion, and nonlinear effects.	PSO2	An	P
CO5	Identify and describe various passive optical components such as connectors, couplers, and gratings, and understand their applications in optical communication systems.	PSO3	Ap	P, M

CO6	Understand the principles and functioning of optical amplifiers and compare different types based on their performance parameters such as gain, noise figure, and bandwidth	PO4/ PSO4	U, E, Cr	C, P, M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (15 Hrs)

Introduction to optical fibers-Total internal reflection-acceptance angle, numerical aperture, Fractional refractive index difference, skew rays, Classification of fibers: based on refractive index profiles, modes guided applications and materials. Fiber drawing and fabrication methods:- Modified chemical vapor deposition (MCVD) and VAD techniques.

Module II (15 Hrs)

Wave Guides: Waves between parallel conducting plane TE, TM and TEM waves, TE and TM waves in Rectangular wave guides, Mode theory of fibers- Different modes in fibers. Dominant mode, Derivations for modal equations for SI and GI fibers. Approximate number of guided modes in a fiber (SI and GI fibers). Comparison of single mode and multimode fibers for optical communications.

Module III (15 Hrs)

Transmission characteristics of optical fibers: Attenuation, absorption, scattering losses, bending losses. Phase and group velocities- V-parameter, Cut off wavelength, Dispersion parameter, bandwidth, rise time and Non linearity coefficient. Impairments in fibers: Group velocity dispersion (GVD), Wave guide and modal dispersions. Polarization mode dispersion (PMD), Birefringence-linear and circular.

Module IV (15 Hrs)

Passive optical components: Connectors, couplers, splices, Directional couplers, gratings: FBGs and AWGs, reflecting stars: optical add drop multiplexers and SLMs.

Active components: Optical Amplifiers (OAs) - Comparative study of OAs- SLA, FRA, FBA EDFA and PDFA based on signal gain, pump efficiency, Noise figure, insertion loss and bandwidth. Design and Characterization of forward pumped EDFA.

References

1. Allen H Cherin, “An introduction to Optical Fibers”, McGraw Hill Inc., Tokyo, 1995.
2. Gerd Keiser, Optical Fiber Communications, McGraw Hill, 2000
3. Govind P.Agrwal, “Fiber Optic Communication systems”, John Wiley & Sons Inc., New York, 1997.
4. John M senior, Optical Fiber Communications, PHI, 1992.
5. Maynbav, Optical Fiber Technology, Pearson Education, 2001.

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1. Ajoy Ghatak and K. Thyagarajan. Introduction to Fiber optics: Cambridge University press, 1999.
2. David Bailey and Edwin Wright, Practical Fiber Optics, Elsevier, 2003.
3. Dennis Derikson, Fiber optic test and measurement, Prentice Hall, 1998.
4. Franz and Jain, Optical Fiber Communication systems: Systems and Components, Narosa Publishers, 2004
5. Joseph C Palais, Optical fiber Communications, Pearson Education.1998.

Semester: VI	Course Code: UK6MNEDOP301
Course Title: Electronic and Optical Communication	**Credits: 4**

Prerequisite: Basic understanding of electronic circuits and signals.

Objective: To provide a comprehensive understanding of electronic communication systems, including analog and digital modulation techniques, cellular communication, satellite communication, and fiber optic communication.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Analyze and design analog modulation systems using techniques such as AM, FM, and PM.
CO2	Describe the operation of digital modulation techniques, including ASK, FSK, PSK, BPSK, and QPSK.
CO3	Explain the principles and technologies behind cellular communication systems and satellite communication.
CO4	Understand the fundamentals of fiber optic communication, including nonlinear effects, soliton-based systems, and WDM.
CO5	Analyze the performance parameters of communication systems, including signal-to-noise ratio (SNR) and bit error rate (BER).
CO6	Design and analyze link budgets and power budgets for fiber optic communication systems.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Analyze and design analog modulation systems using techniques such as AM, FM, and PM.	PO1, PSO3	U	F and C
CO2	Describe the operation of digital modulation techniques, including ASK, FSK, PSK, BPSK, and QPSK.	PO2, PSO1	An	F, C, P

CO3	Explain the principles and technologies behind cellular communication systems and satellite communication.	PO1, PSO1	E	C and P
CO4	Understand the fundamentals of fiber optic communication, including nonlinear effects, soliton-based systems, and WDM.	PO1, PSO1	An	F,C,P
CO5	Analyze the performance parameters of communication systems, including signal-to-noise ratio (SNR) and bit error rate (BER).	PO1, PSO1	An	F,C,P
CO6	Design and analyze link budgets and power budgets for fiber optic communication systems.	PO2	U	F,C,P

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (20 Hrs)

Electronic Communication: Block Diagram of an Electronic Communication System, Electromagnetic Communication Spectrum, Band Designations and Usage, Channels and Base-Band Signals, Noise, SNR and noise figure.

Amplitude Modulation: Definition, Representation, Modulation Index, Expression for Instantaneous Voltage, Power Relations, Frequency Spectrum, Concept of DSBFC, DSBSC, SSBSC Generation and Detection, Limitations of AM, Demodulation, AM Detection, Diode Detector Circuit

Frequency Modulation and Phase Modulation: Definition, Representation, Modulation Index, Frequency Spectrum, Bandwidth Requirements, Frequency Deviation and Carrier swing, Equivalence between FM and PM, Generation of FM using VCO, Demodulation, FM Detector, Block Diagram of FM Transmitter and Receiver, Comparison of AM and FM, Qualitative Idea of Super HeterodyneReceiver.

Module II (10 Hrs)

Sampling Process: Sampling theorem, Interpolation Formula, Quadrature sampling of band pass signals, Reconstruction of a message process from its samples, signal distortion in sampling, practical aspects. PAM, PPM, PWM, Multiplexing- TDM, FDM. Frequency domainanalysis.

Digital Modulation Techniques: Need for Digital Transmission, Block Diagram of Digital Transmission and Reception, Pulse Code Modulation, Sampling, Quantization (Uniform and

Non-uniform), Quantization Error, Companding, Encoding, Decoding,` Regeneration, Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK), Advantages and Disadvantages of Digital Communication.

Module III (10 Hrs)

Cellular Communication: Concept of Cellular Mobile Communication, Frequency Bands, Cell Sectoring and Cell Splitting, Absolute RF Channel Numbers (ARFCN), Frequency Reuse, Roaming and Hand Off, Authentication of SIM Card of Subscribers, IMEI Number, Need for Data Encryption, Network Architecture, Concept and comparisons of GSM, CDMA, TDMA and FDMA, Qualitative concepts of 2G, 3G and 4G, GPS Navigation System.

Satellite Communication: Introduction, Need, Geosynchronous Satellite Orbits, Geostationary Satellite, Advantages of Geostationary Satellites, Satellite Visibility, Transponders (C-Band), Friis Transmission Equation, Path Loss, Ground Station, Simplified Block Diagram of Earth Station, Uplink and Downlink.

Module IV (20 Hrs)

Fiber optic communication: Nonlinear effects in fibers: Kerr effect, SPM, XPM and FWM, SRS, SBS, nonlinear effects in PCF-super continuum generation, nonlinear optical switching. Soliton based systems: introduction to soliton theory and its applications, design and characterization of EDFA, pumping schemes, noise in EDFA – ASE and noise factor. Direct modulation, limitations, external modulation, electro-optic, acousto-optic modulators, dispersion management, Quantum limit of performance-noise and jitter, extinction ratio and BER performance.

Wavelength division multiplexing (WDM) components- add/ drop multiplexers, tunable filters, optical cross connects, system performance parameters. dense wavelength division multiplexing (DWDM) technology – need and requirements- concept of polarization division multiplexing. Design considerations for fiber optic communication systems: link budget analysis, power budget calculation, Performance parameters: signal-to-noise ratio (SNR), bit error rate (BER), and system capacity.

References

1. Roddy and Coolen, Electronic Communications, Pearson.
2. Tomasi, Advanced Electronic Communications Systems, Pearson.
3. Lathi and Ding, Modern Digital and Analog Communication Systems, Oxford.
4. Kennedy, Electronic Communication Systems, Tata McGraw Hill.
5. Frenzel, Principles of Electronic Communication Systems, Tata McGraw Hill.
6. Haykin, Communication Systems, Wiley.
7. Blake, Electronic Communication Systems, Cengage.
8. Kundu, Analog and Digital Communications, Pearson.
9. Couch, Digital and Analog Communication Systems, Pearson.
10. Gerd Keiser, Optical Fiber Communications, McGraw Hill, 2000
11. Govind P.Agrwal, “Fiber Optic Communication systems”, John Wiley & Sons Inc., New York, 1997.
12. John M senior, Optical Fiber Communications, PHI, 1992

Semester: VII	Course Code: UK7MNEDOP401
Course Title: Signals and Systems	**Credits: 4**

Prerequisite: Knowledge in basic electronics.

Objective: To understand the operations of various electronic circuits and developthe circuits for the hardware design.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Differentiate between continuous and discrete time signals, and comprehend the transformation of the independent variable in signal representations
CO2	Understand the principles of LTI systems
CO3	Understand the properties of discrete-time Fourier series
CO4	Understand the convolution and multiplication properties of the Fourier transform and apply them in signal analysis and processing
CO5	Apply the Laplace transform to analyze the behavior of different types of signals

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Differentiate between continuous and discrete time signals, and comprehend the transformation of the independent variable in signal representations	PO1	Ap	P
CO2	Understand the principles of LTI systems	PO1, PSO1	U	C
CO3	Understand the properties of discrete-time Fourier series	PO1, PSO1	U	C
CO4	Understand the convolution and multiplication properties of the Fourier	PO1, PSO1	U	C

	transform and apply them in signal analysis and processing			
CO5	Apply the Laplace transform to analyze the behavior of different types of signals	PO2	Ap	P and M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (10 Hrs)
Signals and Systems: Continuous and discrete time signals, Transformation of the independent variable, Exponential and sinusoidal signals, Impulse and unit step functions, Continuous-Time and Discrete-Time Systems, Basic System Properties.
Linear Time-Invariant Systems (LTI): Discrete-time LTI systems, the Convolution Sum, Continuous-time LTI systems, the Convolution integral. Properties of LTI systems,LTI systems with and without memory, Invariability, Causality, Stability, Unit Step response. Differential and Difference equation formulation, Block diagram representation of first-order systems.

Module II (10 Hrs)
Laplace Transform: Laplace Transform, Inverse Laplace Transform, Properties of the Laplace Transform, Laplace Transform Pairs, Laplace Transform for signals, Laplace Transform Methods in Circuit Analysis, Impulse and Step response of RL, RC and RLC circuits. Laplace transform analysis of systems - Relation between the transfer function and differential equation –Causality and stability - Inverse system - Determining the time domain and frequency response from poles and zeros

Module-III (20 Hrs)
Fourier Series Representation of Periodic Signals: Continuous-Time periodic signals, Convergence of the Fourier series, Properties of continuous -Time Fourier series, Energy spectral density and power spectral density - Frequency response of LTI systems - Discrete-Time periodic signals, Properties of Discrete-Time Fourier series. Frequency- Selective filters, Simple RC high pass and low pass filters.

Sampled data systems- Sampling process-sampling theorem - signal re construction- Zero order and First order hold circuits - Difference equation representations of LTI systems - Discrete form of special functions- Discrete convolution and its properties.

Module IV (20 Hrs)

Z-transform: Definition, Z-transform of elementary signals, Region of convergence, Properties of ROC and Z transform, Inverse Z-transform.

FIR filters: characteristics of practical frequency selective filters-characteristics of FIR filters with linear phase - design of linear phase FIR filters using windows- rectangular, Hamming, Hanning and Kaiser windows, FIR filter design using frequency sampling

IIR filters: Properties of IIR filters-design of IIR digital filters from analog filters Butterworth design-Chebyshev design - impulses invariant transformation- Bilinear transformation.

References:

1. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Education (2007)
2. S. Haykin and B. V. Veen, Signal and Systems, John Wiley & Sons (2004)
3. C. Alexander and M. Sadiku, Fundamentals of Electric Circuits, McGraw Hill (2008)
4. H. P. Hsu, Signals and Systems, Tata McGraw Hill (2007)
5. S. T. Karris, Signal and Systems: with MATLAB Computing and Simulink Modelling, Orchard Publications (2008)
6. W. Y. Young, Signals and Systems with MATLAB, Springer (2009)
7. M. Roberts, Fundamentals of Signals and Systems, Tata McGraw Hill (2007)
8. Bracewell R.N., Fourier Transform & Its Applications, McGraw Hill
9. Farooq Husain , Signals and Systems, Umesh pub.
10. Papoulis A., Fourier Integral & Its Applications, McGraw Hill
11. Taylor F.H., Principles of Signals & Systems, McGraw Hill

Semester: VII	Course Code: UK7MNEDOP402
Course Title: Optics and Optoelectronics - Practical	**Credits: 2**

Prerequisite : Basic knowledge in Optoelectronics and Lasers.

Objective : To empower the students with hands-on experience and to provide practical knowledge about Optoelectronic sources, detectors, devices and sensors.

Learning Outcomes : On completion of the course the student will be able to

CO No.	CO Statement
CO1	Understand the characteristics of optical sources and detectors.
CO2	Analyse the diffraction pattern through various optical devices.
CO3	Evaluate refractive index of substances.
CO4	Verify Malu’s law

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Understand the characteristics of optical sources and detectors.	PSO1	U	P
CO2	Analyse the diffraction pattern through various optical devices.	PO4/PSO2	An, Ap	P
CO3	Evaluate refractive index of substances.	PSO1	E	P
CO4	Verify Malu’s law	PO3/PSO2	Cr, E	P, M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom’s Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT (List of Experiments)

1. Measurement of beam characteristics of lasers
2. Characteristics of laser diode
3. Diffraction through Single slit and Double slit
4. Diffraction through circular aperture
5. Diffraction - reflection grating
6. Diffraction - transmission grating
7. Refractive index of mirror and liquid
8. Acoustic grating – Compressibility of liquids
9. Goniometer – Angle of contact
10. Determination of Brewster's angle
11. Mach – Zehnder interferometer
12. Determination of Stefan's constant
13. Pull – Frich refractometer
14. Characteristics of LED and LDR
15. Characteristics of photodiodes and phototransistors
16. Characteristics of opto-coupler
17. Malu's law
18. Characteristics of solar cell
19. Energy bandgap of Silicon
20. Fermi energy of Copper and fermi temperature
21. Determination of Planck's constant using LED
22. Hall effect

(Similar kind of experiments can also be done. At least 10 experiments should be provided)

Semester: VII	Course Code: UK7MNEDOP403
Course Title: Communication - Practical	**Credits: 2**

Prerequisite: Basic knowledge in signals and systems.

Objective: To empower the students with hands-on experience and to provide practical knowledge about signal generation and its analysis.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Generation of AM, FM signals
CO2	Analyse the modulation and demodulation schemes.
CO3	Analyse the signals from various spectral sources.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Generation of AM, FM signals	PO4/PSO2	An, Ap	P
CO2	Analyse the modulation and demodulation schemes.	PSO1	E	P
CO3	Analyse the signals from various spectral sources.	PO3/PSO5	Cr, E	P, M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT (List of Experiments)

1. AM generation using discrete components
2. AM generation using envelope detector
3. AM detection using envelope detector
4. IF tuned amplifier
5. FM using 555 IC

6. Study of 565 PLL – measurement of lock range and capture range
7. FM generation and demodulation using 565
8. Frequency multiplier using 565
9. PAM modulator and demodulator
10. PWM generation and demodulation using 555 IC
11. PPM generation and demodulation using 555 IC
12. Pseudo Random Binary Sequence generator
13. Delta modulation and demodulation
14. ASK modulation and demodulation
15. FSK modulation and demodulation
16. Digital pulse detector
17. TDM generation
18. BPSK modulation and demodulation

Designing of Optical Systems and Optical Fibers

1. Design and performance analysis of optical communication systems using OPTISYSTEM and OPTSIM
2. Design and performance analysis of various optical networks using OPTISYSTEM
3. Design and analysis of various types of photonic crystal fibers using COMSOL MultiPhysics

Optical Communication

4. Measurement of losses- attenuation, bending in optical fibers.
5. Measurement of numerical aperture
6. Measurement of power gain using Erbium Doped fiber amplifier
7. Study of dispersion in optical fibers
8. Wave length division multiplexing of signals
9. Characterization of FBG and circulator
10. Analog and digital fiber optic links
11. Time division multiplexing of digital signals
12. WDM fiber optic link
13. Optical amplification in a WDM link
14. Adding and dropping of optical channels in a WDM link
15. Testing and analysis of OTDR
16. Testing and analysis of bit error rate & eye pattern analysis
17. Testing and analysis of power budgeting

(Similar kind of experiments can also be done. At least 10 experiments should be provided)

OPTIONALS

Semester: I	Course Code: UK1MNEDOP102
Course Title: Solar Photovoltaics	**Credits: 4**

Prerequisite: Basic Knowledge in semiconductor Physics.

Objective: To introduce the fundamental theories and technological aspects ofpower generation using solar photovoltaic technology.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Remember the principles and concepts in solar photovoltaic field.
CO2	Understand different types of photovoltaic materials and their properties
CO3	Apply the fabrication techniques of thin film technology
CO4	Analyse solar cell parameters
CO5	Design solar cells and PV modules
CO6	Develop materials for solar photovoltaic applications
CO7	Measure losses and quantum efficiency in a solar cell

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Remember the principles and concepts in solar photovoltaic field.	PO1	R	F and C
CO2	Understand photovoltaic materials and their properties	PO1, PO2	U	C
CO3	Apply the fabrication techniques of thin film technology	PO1, PSO1	Ap	P
CO4	Analyse solar cell parameters	PSO5	An	M
CO5	Design solar cells and PV modules	PO2, PSO5	Ap	M
CO6	Develop materials for solar photovoltaic applications	PSO5	Cr	P

CO7	Measure losses and quantum efficiency in a solar cell	PO2, PSO5	E	P

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (10 Hrs)

Solar cell materials and their properties. Solar cell research: technology (silicon, organic, Dye sensitized, perovskites), applications and limitations. Device fabrication: Semiconductor junctions: P-N junction, P-I-N junction and its properties. Solar cell structures: homo & hetero junction solar cells, single & multi-junction solar cells. Substrate and Superstrate configuration.

Module II (20 Hrs)

Fabrication techniques: Diffusion, Electrodeposition, Thin film technology: physical vapour deposition (PVD) techniques, chemical vapour deposition (CVD) techniques- MOCVD and PECVD. Solar cell parameters, Losses in a solar cell: optical losses and electrical losses. Effects of series & parallel resistance, solar radiation and temperature on efficiency. Minimization of optical losses and recombination.

Module III (20 Hrs)

Design of solar cells: high Isc, high Voc, high FF. Characterization of solar cells: Measurements of solar cell parameters, Solar Simulator- I-V measurement, L-I-V characteristics, quantum efficiency measurement.

Module IV (10 Hrs)

PV Modules: solar PV modules from solar cells, series and parallel connections, design and structure of PV modules, power output, batteries for PV systems.DC-DC converters, DC-AC converters, PV system configurations, Hybrid PV systems. Photovoltaic system design and applications.

References

1. Chetan Singh Solanki, Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI, New Delhi, 2011.
2. Larry D Partain (ed.), Solar Cells and their Applications, John Wiley and Sons, Inc, New York, 1995.
3. Martin A. Green, Solar Cells: Operating principles, Technology and System

Applications, Prentice-Hall Inc, Englewood Cliffs, NJ, USA, 1981.
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4. M. D. Archer, Clean Electricity from Photovoltaics, R. Hill, Imperial College Press, 2001.
5. R. Brendel, Thin-Film Crystalline Silicon Solar Cells: Physics and Technology, Wiley-
6. VCH, Weinheim, 2003.
7. Richard H Bube, Photovoltaic Materials, Imperial College Press, 1998.

Semester: II	Course Code: UK2MNEDOP102
Course Title: Nanophotonics	**Credits: 4**

Prerequisite: Basic knowledge in photonics.

Objective: To learn fundamentals of nanotechnology and its applications inPhotonics.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Remember the concepts of nanoscale interactions, photonic band gap, nanolithography and biomaterials
CO2	Understand the nature and properties of nanophotonic materials
CO3	Differentiate quantum - wells, wires, dots, rings, confinements and cutting
CO4	Analyse XRD, Raman, IR, XPS, SEM, TEM and SPM.
CO5	Fabricate nanostructures, photonic crystals, nanophores and carbon nanotubes
CO6	Apply nanophotonics in biotechnology and nanomedicine
CO7	Develop thin films using MBE, PLD and CVD

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Remember the concepts of nanoscale interactions, photonic band gap, nanolithography and biomaterials	PSO1	R	C
CO2	Understand the nature and properties of nanophotonic materials	PO1	U	C
CO3	Differentiate quantum - wells, wires, dots, rings, confinements and cutting	PO4	Ap	M
CO4	Analyse XRD, Raman, IR, XPS, SEM, TEM and SPM.	PO5/PSO5	An	M

CO5	Fabricate nanostructures, photonic crystals, nanophores and carbon nanotubes	PSO5	Ap	P
CO6	Apply nanophotonics in biotechnology and nanomedicine	PSO5	Cr	P
CO7	Develop thin films using MBE, PLD and CVD	PO5/PSO5	Cr	P

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (10 Hrs)

Introduction to nanoscale interaction of photons and electrons. Near field interaction and microscopy- near field optics and microscopy- single molecule spectroscopy nonlinear optical process. Mesoscopic physics and nanotechnologies - trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, quantum mechanical coherence.

Module II (15 Hrs)

Materials for nanophotonics -quantum confined materials -inorganic semiconductors-quantum wells, wires dots and rings-quantum confinement-optical properties with examples-dielectric confinement- super lattices. Compound semiconductors- properties applications- white light-GaN properties-blue LED-white light.

Module III (20 Hrs)

Plasmonics-metallic nanoparticles and nanorods-metallic nanoshells-local field enhancement-plasmonic wave guiding-applications of metallic nanostructures. Nanocontrol of excitation dynamics-nanostructure and excited states-rare earth doped nanostructures-up converting nanophores-quantum cutting. Growth and characterization of nanomaterials- epitaxial growth-MBE-PLDCVD- nanochemistry-XRD- Raman-IR-XPS-SEM- TEM- SPM.

Module IV (15 Hrs)

Organic quantum confined structures- carbon nanotubes-graphene characterization, properties and applications. Concept of photonic band gap – photonic crystals-theoretical modelling-features-optical circuitry-photonic crystal in optical communication nonlinear photonic crystal-applications.

References:

1. Colm Durkan, Current at the Nanoscale, Imperial College Press, 2007.
2. J.M. Martinez-Duart,R.J. Martin Palma,F. Agulle Rueda, Nanotechnology for Microelectronics and Optoelectronics , Elsevier,2006.
3. Lukas Novotny and Bert Hecht, Principles of Nano-Optics, Cambridge University Press, 2006.
4. Paras N. Prasad, Nanophotonics, Wiley Interscience, 2004.
5. Herve Rigneault, Jean-Michel Lourtioz, Claude Delalande, Juan Ariel Levenson,Nanophotonics, ISTE Publishing Company, 2006.
6. John D. Joannopoulo, Robert D. Meade and Joshua N. Winn, Photonic Crystals, Prienceton University Press, 2008.

Semester: III	Course Code: UK3MNEDOP102
Course Title: Basic Electronics - Practical	Credits: 2

Prerequisite: Knowledge of semiconductor devices.

Objective: To empower the students with hands-on experience and to providepractical knowledge about semiconductor devices and their characteristics.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Acquire experimental skills, analyse the results and interpret data
CO2	Ability to design/develop/manage/operate and maintain sophisticated electronic gadgets/systems
CO3	Capacity to identify and solve electronics-related issues and analyze the problems in various sub-disciplines of electronics
CO4	Understand and study the behaviour of the semiconductor devices
CO5	Familiarise the experimental skills to determine the behaviour of semiconductor devices
CO6	Apply the standard device models to explain/calculate critical internal parameters of semiconductor devices
CO7	Understand and characterize the behaviour of power electronic devices

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Acquire experimental skills, analyse the results and interpret data	PO1, PSO5	An	M
CO2	Ability to design/develop/manage/operate and maintain sophisticated electronic gadgets/systems	PO2, PSO5	Ap	P

CO3	Capacity to identify and solve electronics-related issues and analyze the problems in various sub-disciplines of electronics	PO3, PSO5	R, Ap, An	C, P and M
CO4	Understand and study the behaviour of the semiconductor devices	PO1	R and U	F and C
CO5	Familiarise the experimental skills to determine the behaviour of semiconductor devices	PO1, PSO1	Cr, Ap	P
CO6	Apply the standard device models to explain/calculate critical internal parameters of semiconductor devices	PSO5	Ap, An, and E	P and M
CO7	Understand and characterize the behaviour of power electronic devices	PSO5	U, Ap, An	P and M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	10	10	10	10
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	15	15	15	15
Create	15	15	15	15

COURSE CONTENT (List of Experiments)

1. Measurement of Amplitude, Frequency and Phase Difference using CRO.
2. Verification of (a) Norton's Theorem (b) Thevenin's Theorem (c) Superposition Theorem (d) Maximum Power Transfer Theorem.
3. Study of the I-V Characteristics of PN Junction Diode and Zener Diode.
4. Study of Half-wave rectifier without and with shunt capacitor filter– ripple factor for different values of filter capacitors.
5. Study of full wave bridge rectifier without and with shunt capacitor filter – ripple factor for different values of filter capacitors.
6. Designing and testing of 5V/9 V DC regulated power supply and finding its load regulation.
7. Study of the I-V Characteristics of the Common Emitter Configuration of BJT and obtain ri, ro, β.
8. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain ri, ro, α.
9. Study of the I-V Characteristics of JFET/MOSFET.

10. Study of Clipping, Clamping and Voltage Multiplier circuits.
11. Designing of a Single Stage CE amplifier.
12. Study of the Colpitt's and Hartley's Oscillator.
13. Study of the Phase Shift Oscillator

(Similar kind of experiments can also be done. At least 10 experiments should be provided)

Semester: III	Course Code: UK3MNEDOP203
Course Title: Analog and Digital Electronics - Practical	Credits: 2

Prerequisite: Basic knowledge in electronic circuits.

Objective: To empower the students with hands-on experience and to providepractical knowledge about analog and digital circuits, their design and characteristics.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Design and construct different electrical circuits using Op-amp.
CO2	Analyse the various parameters of circuits using Op-amp.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Design and construct different electrical circuits using Op-amp.	PSO1	E, Cr	P, M
CO2	Analyse the various parameters of circuits using Op-amp.	PO3/PSO5	Cr, E, An	P, M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create, **KC- Knowledge Category**: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT (List of Experiments)

1. Differential amplifier- inverting, non-inverting- operational amplifier parameters (IC 741)
2. Op-amp - Adder, Integrator, Differentiator, Clipper and Clamper circuits
3. RC coupled CE amplifier
4. Wien bridge oscillator using op-amp
5. First order low pass and high pass filter
6. Second order low pass and high pass filter
7. Waveform generators using op-amp
8. Schmitt trigger using op-amp
9. Instrumentation amplifier
10. Design of astable and monostable multivibrator
11. Study of 8-bit DAC.
12. Design D/A and A/D Converters IC.
13. Design and Verify the Truth Table for Half Adder and Full Adder Logic Circuits.
14. Study of Multiplexer and De-multiplexer.
15. Flipflops using gates
16. Shift Registers
17. Asynchronous and synchronous counters using flip-flops.

8085 – Software Experiments :

18. Binary addition (8 bit and 16 bit) and subtraction (8 bit).
19. Decimal Addition (DAA).
20. Multiplication and Division (8 bit).
21. Picking of largest/Smallest number from the given data.
22. Arranging the given data in ascending/descending order.
23. Time Delay generation.

(Similar kind of experiments can also be done. At least 10 experiments should be provided)

Semester: IV	Course Code: UK4MNEDOP202
Course Title: Fiber Optic Sensors and Applications	Credits: 4

Prerequisite: Knowledge in fibre optics.

Objective: To familiarize the applications of fiber optics in various fields such as civil structures, aircrafts, nuclear power plants, chemical and petroleum industries and biomedical applications.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Remember the concept of fiber optic sensors and types
CO2	Understand the Fiber Bragg Grating based sensors and their commercial applications
CO3	Design interferometry sensors
CO4	Design and develop fiber optic gyroscopes
CO5	Analyse biomedical sensors and spectral sensors.
CO6	Fabricate distributed fiber optic sensors.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Remember the concept of fiber optic sensors and types	PO1	R	F, C
CO2	Understand the Fiber Bragg Grating based sensors and their commercial applications	PO1, PSO1	U, Ap	C, P
CO3	Design interferometry sensors	PSO5	Ap, Cr	P
CO4	Design and develop fiber optic gyroscopes	PSO5	E, Cr	P, M
CO5	Analyse biomedical sensors and spectral sensors.	PO2, PSO5	An	M
CO6	Fabricate distributed fiber optic sensors.	PSO5	Ap, Cr	P, M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (15 Hrs)

MM and SM fibers for sensing, Lasers & LEDs suitable for sensing, PIN & APDs for fiber optic sensing. Principles of electro optic modulators bulk & integrated optic modulators. Optical sensor types, advantages and disadvantages of fiber optic sensors, Sensor system performance: basic specifications, Sensor functions. Intensity modulated sensors, reflective concept, micro-bendconcept, evanescent fiber sensors, polarization modulated sensors.

Module II (15 Hrs)

In-fiber Bragg grating based sensors – sensing principles – temperature and strain sensing, integration techniques, cross sensitivity, FBG multiplexing techniques. Long period fiber grating sensors- temperature and strain sensing, refractive index sensing, optical load sensors and optical bend sensors, Signal processing techniques for fiber optic sensor.

Module III (15 Hrs)

Interferometric sensors, Mach-Zehnder& Michelson interferometric sensors, Theory-expression for fringe visibility, Fabry-Perot fiber optic sensor – theory and configurations, Sagnac interferometers for rotation sensing Fiber gyroscope sensors – Sagnac effect – open loop biasing scheme – Closed loop signal processing scheme – Faraday effect sensors. Magnetostriction sensors.Lorentz force sensors.

Module IV (15 Hrs)

Biomedical sensors, sensors for physical parameters, pressure, temperature, blood flow, humidity and radiation loss, sensors for chemical parameters. pH, oxygen, carbon dioxide, spectral sensors.Distributed fiber optic sensors – intrinsic distributed fiber optic sensor – optical time domain reflectometry-based Rayleigh scattering – optical time domain reflectometry-based Raman scattering – optical time domain reflectometry-based Brillouin scattering – optical frequency domain reflectometry – quasi-distributed fiber optic sensor.

References

1. Allen Dakin J and Culshow B., (Ed), Optical fiber sensors, Vol I, II, III, Artech House, 1998.
2. Francis T.S Yu, Shizhuo Yin (Eds), Fiber Optic Sensors,Marcel Dekker Inc., New York,2002.
3. Pal B. P, Fundamentals of fiber optics in telecommunication and sensor systems, 14,

Wiley Eastern, 1994.

Additional References

1. Anna Grazia Mignani and Francesco Baldini, Bio-medical sensors using optical fibers, Report on Progress in Physics Vol 59.1, 1996.
2. B.D Gupta, Fiber optic sensors: Principles and applications, New India Publishing Agency, New Delhi., 2006.
3. Eric Udd (Ed), Fiber optic sensors: An introduction for engineers and scientists, John Wiley and Sons Ltd., 1991.
4. Jose Miguel Lopez-Higuera (Ed), Handbook of optical fiber sensing technology, John Wiley and Sons Ltd., 2001.

Semester: IV	Course Code: UK4MNEDOP203
Course Title: Optical Instrumentation	**Credits: 4**

Prerequisite: Basic knowledge in optical phenomena.

Objective: To learn the basic concepts, theories and applications of opticalinstruments.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Remember the principles and concepts of optical phenomena and optometry
CO2	Understand the theories in optical instrumentation
CO3	Analyze optical devices and materials
CO4	Design optical components and interferometers
CO5	Apply interferometry and ellipsometry in research
CO6	Fabricate opto-medical instruments, lenses, camera and projector

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Remember the principles and concepts of optical phenomena and optometry	PSO1	R	F and C
CO2	Understand the theories in optical instrumentation	PSO1	U	C
CO3	Analyze optical devices and materials	PO2	An	M
CO4	Design optical components and interferometers	PO2	E	M
CO5	Apply interferometry and ellipsometry in research	PO1/PSO2	Ap	P
CO6	Fabricate opto-medical instruments, lenses, camera and projector	PO2/PSO5	Cr	P

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (10 Hrs)
Critical angle, linear and angular magnifications, cardinal points, optical aberrations-corrections. Optical materials, optical components, polarizing components. Basics of optical design, ray tracing, fabrication and testing of optical components. Types of optical glass - IR materials - gallium arsenide - optical glass making, IR materials manufacturing- abrasives, polishing compounds - tools and fixtures
- spherical and plano tools - optical fabrication.

Module II (20 Hrs)
Image intensifiers and night vision devices. Telescopes and microscopes-reflecting and refracting telescopes, eyepieces, microscope-objectives, binocular, stereoscopic, phase contrast, polarizing and atomic force microscopes – Airy's disc, resolving power of a telescope and microscope and brightness.

Stops and photographic systems-theory of stops – aperture stop – entrance and exit pupils, tele-centric stop and applications, requirements for photographic objectives – eye as an optical instrument, defects of eye and correction methods, space optics, adaptive optics, large space structures.

Module III (20 Hrs)
Lens design optimization, opto-medical instruments, optical coherence tomography, infrared instrumentation; holographic camera; IR telescopes; Moire self- imaging and speckle metrology. Spectroscopes and interferometers- Fourier transform spectroscopy, gratings and its application in spectroscopes, double beam and multiple beam interferometry – Fabry-Perot interferometer – Michelsonand Twyman and Green interferometers – Zygo, MachZehnder, Jamin and Sagnac interferometers – applications –optical spectrum analyzer.

Module IV (10 Hrs)
Photometry, projection systems and refractometers -different sources for optical experiments – lasers –basic laws of photometry, Abbe and Kohler illuminations – episcope, epi-dioscope, slide and overhead projectors – computer-based projection systems – polarizing instruments. Ellipsometry and applicationsin materials research.

References

1. Fowles G.R., Introduction to Modern Optics, 2nd Edition, Holt, Rienhart and Winston, 1975.
2. Bruce H &Walkar, Optical Engineering Fundamentals, PHI, 2003
3. Warren J. Smith, Modern Optical Engineering: The Design of Optical System, 2nd Edn, McGrew Hill, 1990
4. Douglas A. Skoog, F James Holler and Timothy A Nieman, Principles of Instrumental Analysis, 5th Edn, Hartcourt Image Publishers, 1998
5. Donald F. Jacob, Fundamentals of Opticals Engineering, Mc Grew Hill, 1943
6. Hank H. Karow, Fabrication Methods for Precision Optics, John Wiley and Sons, New York,1993.
7. David Malacara, Optical Shop Testing, John Wiley and Sons, New York, 1992.

Additional References

1. Rudolf Kingslake, Applied Optics and Optical Engineering, Vol: I-V, Academic Press, 1985
2. Daniel Malacara & Zacaria Malacara, Handbook of Optical Design, Marcel Dekker, 2004
3. Albert T Helfrack & William D Cooper, Modern Electronic Instrumentation and MeasurementTechniques PHI, 1990
4. K. Lizuka, Engineering Optics, Springer-Verlag, 1983.

Semester:V	Course Code: UK5MNEDOP302
Course Title: Micro-Electro-Mechanical Systems	Credits: 4

Prerequisite: Basic knowledge in semiconductors and solid mechanics.

Objective: To impart a strong foundation in MEMS fundamentals, including microfabrication, materials science, microfluidics, and microscale physics, essential for designing and manufacturing MEMS devices.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Remember the fundamentals and concepts in smart materials, material processing and its properties to fabricate MEMS devices.
CO2	Understand various sensors and actuators and their principles of operation at the micro scale level.
CO3	Discuss the design and simulation of optical MEMS and its components.
CO4	Discuss the fundamental concepts, manufacturing methods, basic classifications, and practical applications of microfluidics technology in Bio-MEMS.
CO5	Analyze the features and dynamics of microscale fluid flows and calculate the problems with fluid mechanics.
CO6	Apply the concepts, principles, and methods related to microfluidics to the analysis and design of microsystems for advanced research and development applications.
CO7	Apply software practice for designing of microstructures and component modeling.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Remember the fundamentals and concepts in smart materials, material processing and its properties to fabricate MEMS devices.	PO1	R	C
CO2	Understand various sensors and actuators and their principles of operation at the micro scale level.	PO1, PO2	U	F and C
CO3	Discuss the design and simulation of optical MEMS and its components.	PO2, PSO1	Ap,Cr	F, C, P

CO4	Discuss the fundamental concepts, manufacturing methods, basic classifications, and practical applications of microfluidics technology in Bio-MEMS.	PO2, PSO1	Cr	F, C, P
CO5	Analyze the features and dynamics of microscale fluid flows and calculate the problems with fluid mechanics.	PSO5	An	F, C
CO6	Apply the concepts, principles, and methods related to microfluidics to the analysis and design of microsystems for advanced research and development applications.	PSO5	Ap	F, C, P
CO7	Apply software practice for designing of microstructures and component modeling.	PSO5	Ap	C and P

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create, **KC- Knowledge Category**: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (15 Hrs)

MEMS: Introduction to MEMS, smart materials and their properties. Material processing and device fabrication: lithography, doping, thin film growth and deposition, ion implantation, wet and dry etching, wafer bonding, integrated processes, bulk silicon micromachining, surface micromachining, CVD oxide process. Enhanced CVD, physical vapor deposition, DRIE.

Mechanical sensors and actuators: Beam and cantilever–microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor, Piezoelectric sensor and actuators.

Module II (20 Hrs)

MOEMS: An overview; optical MEMS components, micro mirrors, micro lenses, optical sources and detectors for optical MEMS applications, design and simulation of micro sensors, micro actuators and MOEMS-micro fluidic devices, micro fluidic devices using photonic crystal fiber. MOEMS related sensors, micro-optic components, testing and applications.

Bio-MEMS: Microfluidic System- Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in micro conduits, in submicro meter and nanoscale. Micro scale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, microfluidic dispenser, microneedle, micropumps-continuous flow system, micromixers. BioMEMS and detection methods, Biochip sensors and Microarrays.

Module III (20 Hrs)

Applications of MEMS: MEMS devices for applications such as in aerospace, biomedical and process industries. Other applications such as blood pressure monitoring transducers, disposable blood pressure monitoring transducers. MEMS devices - infusion pumps, kidney dialysis, respirators, active noise and vibration control, intelligent structures, micro-robots, smart structures for aircraft, automotive requirements, automobile, satellite, buildings and manufacturing systems. CAD for MEMS, DNA sensor, MEMS based drug delivery, Biosensors-sensors for glucose, uric acid, urea and triglyceride sensor.

Module IV (5 Hrs)

Simulation of microstructures and component modeling: general overview of basic processes (planar-CMOS, bulk-Si,LIGA), physical-chemical determined simulation of selected process steps. Systematic of MEMS components, layout support, examples of element modeling (DAE, FEM).

References

1. Nodium Maluf, "An introduction to micromechanical systems engineering".
2. Marc Madou, "Fundamentals of microfabrication" CRC press (1997).
3. Tai-Ran Hsu, "MEMS & Microsystem, Design and Manufacture", McGraw Hill, 2002.
4. Ristic (Ed) "Sensor Technology & Devices", Artech House Publications (1994).
5. BioMEMS Technologies and Applications, Edited by Wanjun Wang, Steven A. Soper, CRC press Taylor and Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL33487-2724, 2006.

Additional References

1. Banks H.T. Smith R.C. and Wang Y.Smart, "Material Structures - Modeling, Estimation and Control", John Wiley & Sons, New York, 1996.
2. Biomolecular sensing, processing and analysis, Rashid Bashir, Steve T. Werely, Mauro Ferrari, Springer Science and Business Media LLC, 233 Spring Street, New York, NY10013, USA, 2006.
3. Fundamentals and applications of Microfluidics, Nam-Trung Nguyen, Steve T. Werely, Artech house Inc., 685 Canton Street, Norwood, MA02062, 2002.
4. Ellis Meng, Biomedical Microsystems, CRC Press, Boca Raton, FL, 2011. 5. P. Tabeling, S.Chen, Introduction to microfluidics, Oxford University Press, 2010.
5. Alok Pandya ,Vijai Singh, Micro/Nanofluidics and Lab-on-Chip Based Emerging Technologies for Biomedical and Translational Research Applications - Part B, Academic Press, 2022.

Semester: VI	Course Code: UK6MNEDOP302
Course Title: Nanoelectronics	**Credits: 4**

Prerequisite: Basic knowledge in electronic devices.

Objective: To provide students with a foundational understanding of Nanoelectronics, covering essential concepts, devices, fabrication techniques, and potential applications.

Learning Outcomes: On completion of the course the student will be able to

CO No.	CO Statement
CO1	Understand the principles and fundamentals of nanotechnology and nanoelectronics.
CO2	Familiarize with the different fabrication techniques used for creating nanoscale devices.
CO3	Explain the principles and applications of spintronics and magnetic tunnel junctions in nanoelectronic devices.
CO4	Identify the principles of molecular electronics and nanophotonics and their role in advancing nanoelectronic device technology
CO5	Investigate the role of nanoelectronics in biomedical applications.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Understand the principles and fundamentals of nanotechnology and nanoelectronics.	PSO1	U	C
CO2	Familiarize with the different fabrication techniques used for creating nanoscale devices.	PO3	Ap, Cr and An	C, P and M
CO3	Explain the principles and applications of spintronics and magnetic tunnel junctions in nanoelectronic devices.	PO5/PSO4	R, U and Ap	C and P
CO4	Identify the principles of molecularelectronics and nanophotonics and their role in advancing nanoelectronic device technology	PO5/PSO5	U, Ap, An and E	P and M
CO5	Investigate the role of nanoelectronics in biomedical applications	PSO5	Cr, Ap and An	P and M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (10 Hrs)
Introduction to Nanoelectronics: Overview of Nanotechnology and Nanoelectronics, Properties of Nanomaterials: Carbon Nanotubes, Graphene, Nanowires; Quantum Mechanics Principles in Nanoelectronics; Introduction to Quantum Tunneling and Quantum ConfinementEffects

Module II (20 Hrs)
Nanofabrication Techniques: Lithography and Patterning Techniques: Optical lithography, Electron beam lithography, Nanoimprint lithography, Soft lithography techniques.
Thin Film Deposition: Physical vapor deposition (PVD), Chemical vapor deposition (CVD), Atomic layer deposition (ALD), Molecular beam epitaxy (MBE). Nanostructuring Methods: Etching techniques (wet and dry), Plasma etching, Reactive ion etching (RIE), Ion beam milling.

Module III (15 Hrs)
Nanoelectronic Devices: Introduction to Nanoelectronic Devices: Scaling trends in electronics, Overview of nanoscale devices, Importance of surface-to-volume ratio in nanoscale devices, Quantum Dots and Nanowires: Quantum dot devices and applications, Nanowire-based devices and their properties, Synthesis and characterization techniques. Carbon-Based Nanoelectronics: Carbon nanotubes (CNTs) and their properties, Graphene-based devices and applications, Carbon- based electronics and emerging technologies.

Module IV (15 Hrs)
Advanced Nanoelectronics: Spintronics and Magnetic Devices: Basics of spintronics and spin-based electronics, Spin transport and manipulation in nanostructures, Applications in magnetic memory and logic devices, Nanoelectromechanical Systems (NEMS): Principles of NEMS, MEMS vs. NEMS devices, Applications in sensors, actuators, and resonators.
Molecular Electronics and Bioelectronics: Molecular-scale electronic devices, Biomolecular recognition and sensing, Nanoelectronics in Biomedical Applications and Health Monitoring.

References:

1. "Introduction to Nanotechnology" by Charles P. Poole Jr. and Frank J. Owens
2. "Nanomaterials: Synthesis, Properties, and Applications" by A.K. Haghi, G.E. Zaikov, and A.M. Grumezescu
3. "Principles of Nanophotonics" by Sergey V. Gaponenko
4. "Introduction to Quantum Mechanics" by David J. Griffiths
5. "Nanoelectronics: Principles and Devices" by Sergey Edward Lyshevski
6. "Nanoelectronics and Photonics: From Atoms to Materials, Devices, and Architectures"

by Edward L. Wolf

7. "Nanoelectronics: Quantum Engineering of Low-Dimensional Nanoensembles" by Vladislav V. Osipov and Alexander V. Kavokin
8. "Molecular Electronics: From Principles to Practice" by Jean-Pierre Launay and Michel Verdaguer
9. "Spintronics: From Materials to Devices" by Sadamichi Maekawa, Sergio O. Valenzuela, Eiji Saitoh, and Takashi Kimura
10. "Nanoelectronics: Nanowires, Molecular Electronics, and Nanodevices" by Krzysztof Iniewski
11. "Nanoelectronics: Materials, Devices, Applications, 2nd Edition" by Krzysztof Iniewski
12. "Nanoelectronics: Quantum Devices and Systems" by Matthew M. Ziegler, Mark S. Lundstrom, and Jing Guo
13. "Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices" by Rainer Waser and Ron Waser

Semester: VII	Course Code: UK7MNEDOP404
Course Title: Image Processing	**Credits: 4**

Prerequisite: Basic knowledge in digital image processing.

Objective: To provide basic of digital image representation and processingtechniques.

Learning Outcomes: On completion of the course, the student will be able to

CO No.	CO Statement
CO1	Remember the fundamentals and concepts in signal processing.
CO2	Discuss about various transforms of two-dimensional sequences.
CO3	Discuss about the two-dimensional transform coding.
CO4	Design and development of spatial filtering
CO5	Design and development of wiener filtering
CO6	Apply software practice for designing of image compression technique.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Remember the fundamentals and concepts in signal processing.	PO1	R	C
CO2	Discuss about various transforms of two-dimensional sequences.	PO2	U	F
CO3	Discuss about the two-dimensional transform coding.	PO2	Ap,Cr	C
CO4	Design and development of spatial filtering	PSO2	Cr	M

CO5	Design and development of wiener filtering	PSO2	Cr	P
CO6	Apply software practice for designing of image compression technique.	PSO5	Ap	M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create, **KC- Knowledge Category**: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (15 Hrs)

Introduction, Digital Image Fundamentals: elements of visual perception, light and electromagnetic spectrum, image sensing and acquisition, image sampling and quantization, some basic relationship between pixels. Intensity Transformations: Basics of intensity transformations, some basic intensity transformation functions, histogram processing.

Module II (15 Hrs)

Spatial Filtering: fundamentals of spatial filtering, smoothing and sharpening filters. Frequency domain Filtering: Background, preliminary concepts, sampling, Fourier transforms and DFT, 2-D DFT and properties, frequency domain filtering, low pass filters, high pass filters, implementation.

Module III (15 Hrs)

Image restoration and Reconstruction: Noise models, restoration in the presence of noise, linear positive invariant degradations, inverse filtering, Wiener filtering, constrained least square filtering, geometric mean filter.

Module IV (15 Hrs)

Image Compression: fundamentals, basic compression methods. Morphological Image Processing: preliminaries, erosion and dilation, opening and closing, basic morphological algorithms. Image Segmentation: fundamentals, point, line and edge detection, thresholding, region based segmentation, use of motion in segmentation.

References:

1. Jain, A. K. (1989). Fundamentals of digital image processing. Englewood Cliffs, NJ: Prentice Hall.
2. Pratt, W. K. (2007). Digital image processing: PIKS Scientific inside (Vol. 4). Hoboken, New Jersey: Wiley-interscience.
3. Aggarwal, C. C., &Zhai, C. (Eds.). (2012). Mining text data. Springer Science & Business Media.
4. Jurafsky, D. (2000). Speech & language processing. Pearson Education India.
5. Gonzalez, R. C., & Woods, R. E. (2002). Digital image processing.

Semester: VIII	Course Code: UK8MNEDOP401
Course Title: Laser Remote Sensing	Credits: 4

Prerequisite: Knowledge in lasers.

Objective: To expertise students on the fundamentals of laser remote sensing andits design considerations.

Learning Outcomes: On completion of the course, the student will be able to

CO No.	CO Statement
CO1	Understand the structure and composition of Earth's atmosphere.
CO2	Discuss about different types of clouds and its properties.
CO3	Explain laser remote sensing methods.
CO4	Apply lidar inversion methods for atmospheric measurements.
CO5	Design lidar system components.
CO6	Analyse airborne and space borne (satellite) lidar systems.

Tagging Course Outcomes

CO	CO Statement	PO/ PSO	CL	KC
CO1	Understand the structure and composition of Earth's atmosphere.	PO1	R	F, C
CO2	Discuss about different types of clouds and its properties.	PO2	U	P
CO3	Explain laser remote sensing methods.	PO2	Ap, Cr	C
CO4	Apply lidar inversion methods for atmospheric measurements.	PSO5	Ap	M
CO5	Design lidar system components.	PO2/PSO5	Ap, E	P, M
CO6	Analyse airborne and space borne (satellite) lidar systems.	PSO5	An	M

(**CL- Cognitive Level**: R- Remember, U- Understand, Ap- Apply, An- Analyse, E- Evaluate, Cr- Create,
KC- Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

Assessment Pattern (Internal & External)

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	15	15	15	15
Understand	15	15	15	15
Apply	35	35	35	35
Analyse	15	15	15	15
Evaluate	10	10	10	10
Create	10	10	10	10

COURSE CONTENT

Module I (20 Hrs)

Earth's atmosphere – basics of different regions of atmosphere, composition, structure and dynamics of atmosphere, important meteorological parameters and their influence in climate. Aerosols, optical properties and their role in Earth's climate and radiation budget.

Clouds: different types of clouds, clouds properties, high altitude cirrus clouds, influence of clouds on weather and climate modification. Atmospheric pollution, different types of pollutants and the sources conventional methods of measurements and limitations. Importance of air quality measurement and environmental monitoring.

Module II (10 Hrs)

Remote sensing of atmosphere, passive and active methods, laser remote sensing fundamentals, advantages. Laser remote sensing methods, interaction of laser radiation with atmosphere, various scattering methods, back scattering configurations, absorption methods, basics of long path absorption and differential absorption methods.

Module III (20 Hrs)

Rayleigh, Raman and Mie lidar configurations, differential absorption lidar (DIAL) system. Lidar equation lidar inversion methods, application of lidar for atmospheric measurements.

Lidar system components and design, monostatic and bistatic configurations, lidar systems for the measurement of aerosols, clouds, ozone, water vapor, temperature etc. Essential elements of a lidar and DIAL system.

Module IV (10 Hrs)

Advanced lidar systems: airborne and space borne (satellite) lidar for regional and global studies. CALISPO and other lidar missions. Air borne and space borne lidars: Basic structures design and technology requirements and optimization of system parameters.

References:

1. E.D. Hinkley (Editor), Laser Monitoring of Atmosphere, Springer Verlag, 1976.
2. J. McCarteny, Optics of Atmosphere, E. John Wiley & Sons, 1982.
3. Monte Ross, Laser Applications, Academic Press, 1973.
4. Raymond M. Measures, Laser Remote Sensing and Applications, John Wiley & Sons, 1984.

Additional References:

1. Raymond M. Measures (Ed) Laser Remote Chemical Analysis, John Wiley & Sons, 1988.
2. Fiocco G., Lidar Systems of Aerosol Studies, An Outline in Handbook for MAP, Vol.13, 56- 68, SCOSTEP Secr., University of III. Urbana, III, 1984.
3. P. Caagani and S. S Sandroni (Editor)Optional Remote Sensing of the Air Pollution, Elsevier science Publisher B. V, pp. 123-142, 1984.
4. Reagan. J.A., McCormick, M.P., and Spinhirne, J.D., Lidar Sensing of clouds in the atmosphereand Stratosphere, Proc. IEEE, 77, pp. 433-448, 1989.
5. Winker, M.D., Couch, R.H., and McCormick, M.P., Proc. IEEE, 84, pp. 164-180, 1996.
6. Muller, D., K. Franke, F. Wagner, D. Althausen, A. Ansmann, and J. Heintzenberg, Vertical Profiling of Optical and Physical Particle Properties over the Tropical Indian Ocean with six wavelength lidar, I. Seasonal cycle, J. Geophysics. Res. 106, 28,567-575, 2001.

Reg. No.: …………………………..

Name: ……………………………...

UNIVERSITY OF KERALA

First Semester Electronics and Photonics (Minor) for B.Sc. Hons. Degree Examination, January 2025

Course Code: Name of the Course

(2024 Admission Regular)

Time: 3 Hours **Max. Marks: 60**

Part – A

Answer ***any seven*** questions. Each question carries ***two*** marks.

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

(7x2=14 Marks)

Part – B

Answer ***any four*** questions. Each question carries ***four*** marks.

11.
12.
13.
14.
15.
16.

(4x4=16 Marks)

Part – C

Answer any ***three*** questions. Each question carries ***ten*** marks.

17.
18.
19.
20.
21.

(3x10=30 Marks)