Annexure - 30

Faculty of Engineering and Technology
Bhagat Phool Singh Mahila Vishwavidyalaya,
Khanpur Kalan (Sonepat), Haryana-131305
Office No. 01263-283124, www.bpsmv.ac.in

Scheme and syllabi Ph.D Course work for Faculty of Engineering and Technology

S. No	Code	Course Title	Hrs/Week			Total Credit	Marks		Total Marks
			L	T	P		Internal Marks	External Marks	
1.	PHE-301	Research Methodology	4	0	0	4	20	80	100
2.	CPE-RPE-022	Research and Publication Ethics	2	0	0	2	10	40	50
3	*	Department Specific Domain Core Course	4	0	0	4	20	80	100
4	PHE-302	Literature Survey and Seminar	2	0	0	2	50	--	50
Total			12	0	0	12	100	200	300

Note:-

- The duration of the Pre-Ph.D. course will be of one semester.
- Each student will have to opt one Departmental Elective Course out of the list of Department Electives as per suitability related to the topic and area of research and domain of the study as suggested by supervisor. Moreover, the Supervisor in consultation with Chairperson and DRC may offer other Departmental Elective Course not included in the list of Department Electives as per suitability related to the area of research chosen by students and domain of the study as approved by DRC & PGBOS. The students will be allowed to use non-programmable scientific calculator. However, sharing/ exchange of calculator is prohibited in the examination.
- Electronic gadgets including cellular phones are not allowed in the examination
- After successful, completion of pre- Ph. D course works, the Department will conduct the DRC for the registration of respective candidate with next six months.
- The Minimum passing marks for Ph.D Course work will be applicable as per Ph.D Ordinance

Department of Electronics and Communication Engineering

*List of Department Specific Domain Core Course

Sr. No.	Course Code	Course Title
1	PHE-512	Photonic Networks
2	PHE-513	Organic Electronics
3	PHE-514	Nanophotonics
4	PHE-515	Future Optical Access Network
5	PHE-516	Wireless technologies: 5G and Beyond
6	PHE-517	Advanced VLSI Interconnects
7	PHE-518	Integrated Circuit Design
8	PHE-519	Hybrid Electric Vehicles
9	PHE-520	Life Cycle Assessment of Renewable Systems
10	PHE-521	Bio-Energy Technologies
11	PHE-522	Emerging Technologies in Renewable Energy Sources
12	PHE-523	Smart Solar Energy and E-Mobility
13	PHE-524	Renewable Energy Grid Integration
14	PHE-525	Integrated/Hybrid Energy Systems
15	PHE-526	Data Warehousing
16	PHE-527	Robotics and Autonomous Systems
17	PHE-528	Computer Vision and Applications
18	PHE-529	AI Applications in Image and Video Processing

Organic Electronics

PHE-513
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Content

Unit –I	
	10 Hours
Organic and Inorganic Materials & Charge Transport: Introduction; Organic Materials: Conducting Polymers and Small Molecules, Organic Semiconductors: p-type, n-type, Ambipolar Semiconductors, Charge Transport in Organic Semiconductors, Charge Transport Models, Energy Band Diagram, Organic and inorganic materials for: Source, Drain and Gate electrodes.	
Unit –II	
	10 Hours
Device Physics and Structures: Organic Thin Film Transistors: Overview of Organic Field Effect Transistor (OFET): Operating Principle; Classification of Various Structures of OFETs; Output and Transfer Characteristics; OFETs Performance Parameters: Impact of Structural Parameters on OFET; Extraction of Various Performance Parameters, Advantages, Disadvantages and Limitations	
Unit –III	
	10 Hours
Organic Device Modeling and Fabrication Techniques: Modeling of OTFT, Different Structures, Origin of Contact Resistance, Contact Resistance Extraction, Analysis of OFET Electrical Characteristics, Validation and Comparison of OFETs. Organic Devices and Circuits, Fabrication Techniques.	
Unit –IV	
	10 Hours
OLEDs and Organic Solar Cells Organic Light Emitting Diodes (OLEDs): Introduction; Different Organic Materials for OLEDs; Classification of OLEDs, Output and Transfer Characteristics; Various Optical, Electrical and Thermal properties, Advantages, Disadvantages and Limitations. Organic Solar Cells: Introduction, Materials, various properties, Characteristics, Advantages, Disadvantages and Limitations and Applications.	

Suggested Text Books

1.	Hagen Klauk, Organic Electronics: Materials, Manufacturing and Applications; Wiley-VCH Verlag Gmbh & Co. KGaA, Germany, 2006.
2.	Klaus Mullen, Ullrich Scherf, Organic Light Emitting Devices: Synthesis, Properties and Applications, Wiley-VCH Verlag Gmbh & Co. KGaA, Germany, 2005.
3.	Klaus Mullen, Ullrich Scherf, Organic Light Emitting Devices: Synthesis, Properties and Applications, Wiley-VCH Verlag Gmbh & Co. KGaA, Germany, 2005.

Note: The examiner is required to set EIGHT questions in all carrying equal marks covering the entire syllabus. The candidate is required to attempt FIVE questions.

Photonic Networks

PHE-512
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Content

Unit –I	
Introduction: Introduction to basic optical communication & devices, WDM optical Network evolution.Optical Multiplexing Techniques: Wavelength Division multiplexing, Time division Multiplexing & code division multiplexing.	10 Hours
Unit –II	
All Optical Networks: Amplification in all optical networks, All optical subscriber access networks, Design issues	10 Hours
Unit –III	
All Optical Networks: Amplification in all optical networks. All optical subscriber access Networks, Design issues.	10 Hours
Unit –IV	
Optical Switching & Routing: Optical switching, example of an optical switch using 2 x 2 Coupler, evolution of switching technologies, switching architectures, Micro Electro Mechanical Systems (MEMS), optical routers, wavelength converters, Add drop multiplexers with & without wavelength conversions.	10 Hours

Suggested Text Books

1.	Uyless Black, 'Optical Networks', Pearson Education, 2008
2.	D.K. Mynbaeu & L. Scheiner, 'Fiber Optic Communication Technology', Pearson Edu. Asia, 2008
3.	C. Siva Ram Murthy & M. Gurusamy, 'WDM Optical Networks' Pearson Education, 2009
4.	RG Gallager & D Bertsekas, 'Data Networks'. PHI. 2006.

Note: The examiner is required to set EIGHT questions in all carrying equal marks covering the entire syllabus. The candidate is required to attempt FIVE questions.

1483

NANOPHOTONICS

PHE-514
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Content

Unit –I	
Introduction: Introduction to Nanophotonics, Integrated Photonics, Photonic Crystals, Slot Waveguide, Silicon Nanowire Waveguide.	10 Hours
Unit –II	
Plasmonics: Introduction, Plasma Physics, Surface Plasmon Polariton, Hybrid Plasmonics Waveguide, Metal strip hybrid plasmonic waveguide, Hybrid Plasmonic Waveguide structure and Design.	10 Hours
Unit –III	
HPW for Nanoscale Optical Confinement: Introduction, HPW design for nanophotonics technology, performance analysis of waveguide for interconnects, Modal Properties of Waveguide, Modal structure and characteristics, Optical performance of waveguide, HPW for long-range propagation and subwavelength optical confinement.	10 Hours
Unit –IV	
Performance of Nanophotonics for optical confinement. Grating based Waveguide with High Nonlinearity. Hybridization of plasmonic and photonic modes for nano-scale photonic devices, Nanophotonics waveguide for low-loss subwavelength optical confinement, Nanophotonics platform for HPW, Nanophotonic coupler based on HP waveguide and performance.	10 Hours

Suggested Text Books

1.	Vittorio M.N.Passaro, "Advances in Photonic Crystals", Publisher InTech, 2013
2.	M.Ohtsu, "Progress in Nano-Electro- Optics V", Springer-Verlag Berlin,1993.
3.	C. Siva Ram Murthy & M. Gurusamy, 'WDM Optical Networks' Pearson Education, 2009
4.	A.Yariv, "Optical Electronics in Modern Communications", Oxford Series in electrical & Computer Engineering, Oxford University Press, New York, 5th edition, 1997.
5.	Robert W. Boyd, "Nonlinear optics." San Diego, Academic Press, 2008.

Note: The examiner is required to set EIGHT questions in all carrying equal marks covering the entire syllabus. The candidate is required to attempt FIVE questions.

1484

Future Optical Access Network

PHE-515
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Content

Unit –I	
Introduction to Future Optical Access Network (FOAN)—A Path for Disruptive Technology Integration: Introduction; Characteristics of FOAN, Impact and benefits of FOAN on industries and societies, need of Future Optical Access Network, Future Optical Access Network deployment, classification of optical access network and next generation access network.	10 Hours
Unit –II	
FOAN Access Network Subsystems: Introduction of FOAN enabling active and passive components. Converged network adaptors (CAN): Optical Connectors, Optical Couplers, Optical Isolators, Optical Circulators, Mach-Zehnder Modulator (MZM), Coexistence Component/Elements-Wavelength Division Multiplexer, Gratings: Fiber Bragg Grating, Thin-Film Filters, Arrayed Waveguide Gratings, Optical Add-Drop Multiplexer, Tunable Filters, Optical Splitter, Optical Sources.	10 Hours
Unit –III	
FOAN Architectures Enabling FTTX/5G/6G/IoT/Smart City Applications and Services: Introduction, Need of Convergence of Optical and Wireless Network: Mobile Communication Technologies, Optical Fiber Communication Networks and Technologies, FOAN Network Features and Characteristics. Converged and Coexistent Architecture: Convergence Layer, Coexistent Layer, Optical Distribution Network (ODN), Front-End Access Network. Flexible Access System Architecture (FASA), Future Service Adaptive Access/Aggregation Network (SAAN), Free Space Optics (FSO)-Optical Wireless (OW)-Enabled TWDM-NG-PON2 Architecture. Software Defined Optical Network (SDON).	10 Hours
Unit –IV	
FOAN: Design-Deployment and Maintenance Cost Analysis: Introduction, FOAN Design Aspect, FOAN Deployment Aspect, FOAN Cost Classification, FOAN Infrastructure Elements and Cost Analysis, Total Services Long-Run Incremental Cost (LRIC) Analysis. FOAN Design and Deployment Cost Analysis: Technology Scenario 1: Fiber-To-The-Premises (FTTP) with no Reuse Provision, Technology Scenario 2: FTTP with Re-Use Provision, Technology Scenario 3: FTTP with 5G/6G Wireless in Local Access, Scenario 4: FTTP with Fixed Wireless Access (FWA) Nodes/LR-VDSL, Technology Scenario 5: G.Fast/DOCSIS Over Fiber and Copper Cable-Mixed Technology. Comparison of cost for Implementation of Technology Scenario.	10 Hours

Suggested Text Books

1.	European Union (2020) State of play brittany region France. Feb-2022, https://project-2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1646259877.pdf
2.	Ghobakhloo M (2018) The future of manufacturing industry: A strategic roadmap toward Industry 4.0. J Manuf Technol Manag, 910–936. https://doi.org/10.1108/JMTM-02-2018-0057.
3.	Hina (2020) Investing in optical networks prerequisite for digitisation and recovery from crisis. total croatia news. https://www.[illegible]-investing-in-optical-networks-prerequisite-for-digitisation-and-recovery-from-crisis
4.	Huawei (2019) All optics campus in Cairo: A Case Stud. https://e.huawei.com/in/case-studies/[illegible]
5.	Huawei (2022) VOYAH builds All-Optical networks with Huawei https://e.huawei.com/[illegible]access-2021/industry-optix-[illegible]

1485

Wireless technologies: 5G and Beyond

PHE-516
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Content

Unit –I	10 Hours
5G NR Overview: Introduction and Motivation, Adaptive modulation and coding, Time-domain and frequency-domain frame structure, 5G NR Numerology, Hybrid Automatic repeat request protocol.	
Unit –II	**10 Hours**
5G transmit and receive chain for data and control information: CRC, Transport block segmentation/concatenation, Rate matching/rate recovery, Interleaving/deinterleaving.	
Unit –III	**10 Hours**
Cell-free/distributed wireless system: Introduction and Motivation, System model for uplink/downlink, Channel modelling, Channel estimation, Beamforming techniques, Centralized/Decentralized uplink and downlink operation, Capacity bounds and spectral efficiency.	
Unit –IV	**10 Hours**
mmWave MIMO Wireless Systems: Introduction and motivation, millimetre wave propagation and channel models, Analog, Digital and Hybrid Processing, Sparse channel estimation.	

Suggested Text Books

1.	Erik Dahlman, Stefan Parkvall, Johan Skold, ``5G NR: The Next Generation Wireless Access Technology``, Academic Press, 2018.
2.	Sassan Ahmadi, ``5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio Standards``, Academic Press, 2019.
3.	Özlem Tugfe Demir, Emil Björnson and Luca Sanguinetti, "Foundations of User-Centric Cell-Free Massive MIMO", Foundations and Trends® in Signal Processing, Now publishers, 2021.

Note: The examiner is required to set EIGHT questions in all carrying equal marks covering the entire syllabus. The candidate is required to attempt FIVE questions.

1486

Advanced VLSI Interconnects

PHE-517
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Content

Unit –I	
	10 Hours
Preliminary concepts: Interconnects for VLSI applications, metallic interconnects, optical interconnects, superconducting interconnects, advantages of copper interconnects, challenges posed by copper interconnects, fabrication process, even and odd mode capacitances, miller theorem, transmission line equations, resistive interconnection as ladder network, propagation modes in microstrip interconnection, slow wave mode propagation, propagation delays.	
Unit –II	
	10 Hours
Parasitic extraction: Parasitic resistance, effect of surface/interface scattering and diffusion barrier on resistance. Capacitance: parallel-plate capacitance, fringing capacitance, coupling capacitance, methods of capacitance extraction, Inductance: self-inductance, mutual inductance, methods of inductance extraction, high frequency losses, frequency dependent parasitics, skin effect, dispersion effect.	
Unit –III	
	10 Hours
Modeling of interconnects and Crosstalk analysis: Elmore model, Transfer function model, even and odd mode model, Time domain analysis of multiconductor lines, Finite Difference Time Domain (FDTD) method, performance analysis using linear driver (Resistive) and nonlinear driver (CMOS), advanced interconnect techniques to avoid crosstalk. **Future VLSI Interconnects:** Optical interconnects, Superconducting interconnects, Nanotechnology interconnects, Silicon nanowires, Carbon nanotubes, Graphene nanoribbons, system issues and challenges, material processing issues and challenges, design issues and challenges.	
Unit –IV	
	10 Hours
Carbon nanotube and Graphene nanoribbon VLSI interconnects: Quantum electrical properties: quantum conductance, quantum capacitance, kinetic inductance, Carbon nanotube (CNT) and Graphene nanoribbon (GNR) interconnects, electron scattering and lattice vibrations, electron mean free path, single-wall CNT and single layer GNR resistance model, multi-wall CNT and multi-layer GNR resistance model, transmission line interconnect models, performance comparison of CNTs, GNRs and copper interconnects.	

Suggested Text Books	
1.	High-Speed VLSI Interconnects, Ashok K. Goel, 2007.
2.	Advanced Nanoscale ULSI Interconnects: Fundamentals and Applications, Y.S. Diamand, 2009.
3.	Carbon nanotube and Graphene Device Physics, H.S Philip Wong and Deji, Akinwande, 2011.

Note: The examiner is required to set EIGHT questions in all carrying equal marks covering the entire syllabus. The candidate is required to attempt FIVE questions.

1487

Integrated Circuit Design

PHE-518
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Content

Unit –I	10 Hours
Need for low power VLSI chips. Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. Device & Technology Impact on Low Power, Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.	
Unit –II	**10 Hours**
Power estimation: Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation. Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.	
Unit –III	**10 Hours**
Low Power Design: Circuit level: Power consumption in circuits. Flip Flops & Latches design, high capacitance nodes, low power digital cells library Logic level: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. Operational Amplifier: Applications of operational Amplifier, theory and Design; Definition of Performance Characteristics: Design of two stage MOS Operational Amplifier, two stage MOS operational Amplifier with cascodes, MOS telescopic-cascode operational amplifiers, MOS Folded-cascode operational amplifiers. Bipolar operational amplifiers.	
Unit –IV	**10 Hours**
Nonlinear Analog Circuits: Voltage controlled oscillator. Comparators, Analog Buffers, Source Follower and Other Structures. Phase Locked Techniques: Phase Locked Loops (PLL), closed loop analysis of PLL. Digital-to-Analog (D/A) and Analog-to-Digital (A/D) Converters. OTA & Switched Capacitor filters: OTA Amplifiers. Switched Capacitor Circuits and Switched Capacitor Filters.	

Suggested Text Books

1.	Gary K. Yeap, Practical Low Power Digital VLSI Design, KAP, 2002
2.	Rabaey, Pedram, Low power design methodologies Kluwer Academic, 1997
3.	D. A. Johns and Martin, Analog Integrated Circuit Design, John Wiley, 1997.
4.	R Gregorian and G C Temes, Analog MOS Integrated Circuits for Signal Processing. John Wiley, 1986.
5.	Behzad Razavi. "Principles of data conversion system design", S.Chand and company Ltd, 2000, John Wiley
6.	Kenneth R. Laker, Willy M.C. Sensen, " Design of Analog Integrated ckts and sys", McGraw Hill, 1994.

Note: The examiner is required to set EIGHT questions in all carrying equal marks covering the entire syllabus. The candidate is required to attempt FIVE questions.

1458

Hybrid Electric Vehicles

PHE-519
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Course Objective: The objective of this course is:

- To understand the basic principles, components, and functioning of hybrid electric vehicles (HEVs).
- To explore various types of HEVs and their design considerations.
- To study the control strategies and energy management systems used in HEVs.
- To analyze the environmental, economic, and performance aspects of HEVs.

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

- Understand the basic principles and components of hybrid electric vehicles.
- Analyze and design hybrid powertrain configurations for optimal performance and efficiency.
- Implement energy management strategies to optimize power usage in HEVs.
- Evaluate the environmental, economic, and performance aspects of hybrid electric vehicles.

Content

Unit –I	10 Hours
Introduction to Hybrid Electric Vehicles Basic Concepts: Hybrid electric vehicle (HEV) vs. conventional vehicles, and battery electric vehicles (BEVs); Types of Hybrid Vehicles: Series, parallel, and series-parallel hybrids; Components of HEVs: Internal combustion engine (ICE), electric motor, power electronics, and energy storage systems (batteries and capacitors); Energy Flow in HEVs: Powertrain configurations and energy conversion processes; History and Development: Evolution of HEVs, from early prototypes to modern commercial vehicles.	
Unit –II	**10 Hours**
Power train Design and Vehicle Dynamics Hybrid Powertrain Design: Sizing and selection of engine, motor, battery, and transmission; Transmission Systems in HEVs: Single-speed and multi-speed transmissions, continuously variable transmission (CVT), and dual-clutch systems; Vehicle Performance and Efficiency: Fuel efficiency, acceleration, regenerative braking, and driving cycle performance; Powertrain Configuration: Impact of powertrain architecture on vehicle weight, performance, and energy consumption; Energy Storage and Batteries: Types of batteries used in HEVs, charging/discharging cycles, and state-of-charge management.	
Unit –III	**10 Hours**
Energy Management and Control Strategies Energy Management Systems (EMS): Functionality of EMS, optimal power distribution between ICE and electric motor; Control Strategies: Rule-based control, optimization-based control, fuzzy logic control, and predictive control; Regenerative Braking: Principles of regenerative braking, energy recovery, and storage; Operating Modes: Pure electric mode, engine-only mode, hybrid mode, and their transitions; Real-Time Monitoring and Adaptive Systems: Dynamic energy management for different driving conditions (urban, highway, etc.).	
Unit –IV	**10 Hours**
Environmental, Economic, and Performance Analysis of HEVs Environmental Impact: Reduction in greenhouse gas emissions, fuel consumption, and lifecycle assessment of HEVs; Economic Considerations: Cost of ownership, fuel savings, government incentives, and total cost of vehicle life; Battery Technologies and Their Impact: Environmental effects of battery production, recycling, and second-life applications; Performance Evaluation: Comparison of HEVs with conventional vehicles and BEVs in terms of efficiency, performance, and emissions; Market Trends and Future Directions: Emerging technologies, hybridization of new powertrains, and future hybrid vehicle	

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designs.	
Suggested Text Books	
1.	"Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives" by Tom Denton.
2.	"Fundamentals of Hybrid Electric Vehicles" by M. R. D. K. K. L. Rao.
3.	"Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain.
4.	Research papers and industry reports on the latest trends in hybrid vehicle technology and energy management strategies.

Note: Nine questions will be set in all by the examiners taking two questions from each unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

C

Life Cycle Assessment of Renewable Systems

PHE-520	**Total Credits: 4**
L T P	**Internal Marks: 20**
4 0 0	**External Marks: 80**
	Total Marks: 100

Course Objective: The aim of this course is to:

- U To be able to understand the characteristics of life cycle assessment.
- To be able to understand the risk and life cycle framework for sustainability.
- To be able to understand the life cycle assessment of renewable energy sources.

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

- Understand the characteristics of life cycle assessment.
- Understand the risk and life cycle framework for sustainability.
- Understand the life cycle assessment of renewable energy sources.

Content

UNIT- I	10 hrs
Life Cycle Analyses An introduction to sustainability concept and life cycle analyses, introduction to material flow and waste management, study of water resources and food nexus. **Main Characteristics of Life Cycle Assessment** What is LCA?, role of LCA in relation to products, role of LCA in wider applications, strength and limitations of LCA, LCA as part of a tool box, management of LCA projects.	
UNIT- II	**10 hrs**
Life Cycle Framework Risk and life cycle framework for sustainability: introduction, risk, environmental risk assessment, example chemicals and health effects, character of environmental problems.	
UNIT- III	**12 hrs**
Life Cycle Assessment of Renewable Energy Sources Life cycle assessment of biodiesel from palm oil, life-cycle assessment of bio methane from lignocelluloses biomass, application of life cycle assessment on agricultural production systems with reference to lignocelluloses biogas and bio ethanol production as transport fuels.	
UNIT- IV	**12 hrs**
Life Cycle Inventory and Impact Assessments Life cycle inventory and impact assessments, unit processes and system boundary, data quality, procedure for life cycle impact assessment, LCIA in practice with examples, interpretation of LCIA results. **ISO Terminologies** Factors for good LCA study, ISO terminologies, LCA steps recap, chemical release and fate and transport, and green sustainable materials.	

Suggested Text Books/References

1.	B. Jeroen, Guinee, *Hand Book on Life Cycle Assessment*, Kluwer Academic Publications.
2.	K.Walter, *Background and Future Prospects in life Cycle Assessment*, Springer.
3.	Anoop Singh , *Life Cycle Assessment of Renewable Energy sources*, Springer.

Note: Nine questions will be set in all by the examiners taking two questions from each unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

1491

Bio-Energy Technologies

PHE-521 | **Total Credits: 4**

L T P | **Internal Marks: 20**

4 0 0 | **External Marks: 80**

Total Marks: 100

Course Objective: The objective of this course is:

- To provide knowledge of bio-energy and bio-gas.
- To impart knowledge of applications of bio-energy.
- To understand the working of bio-gas plant.
- To understand Bio-mass resource potential and assessment for energy generation.

Content

Unit –I	08 Hours
Basics of Bio-Energy Introduction to biogas, utility of biogas, chemical composition, properties of biomass, up gradation of biogas, different types of materials used for the production of biogas, size reduction, briquetting, drying, storage and handling of biomass.	
Unit –II	**10 Hours**
Biomass and Bio-Fuels Energy plantation, biogas generation, types of biogas plants, applications of biogas and energy from wastes, introduction to anaerobic digestion technology, different stages of production of biogas. characteristics of bio-diesel, materials and methods, and its applications, alcoholic fermentation process, technologies and its applications.	
Unit –III	**10 Hours**
Operational Parameters Different factors contribute the production of biogas like retention period, loading rate, temperature, carbon nitrogen (CN) ratio, acidity and alkalinity (PH), presence of toxic substances, kinetics and mechanism- high rate digesters for industrial waste water treatment.	
Unit –IV	**10 Hours**
Biogas plant Important parts of a biogas plant and designing a biogas plant. different categories of bio-gas plants like domestic, institutional and community. classification of biogas plants such as batch type, semi continues type and continuous type, incineration-processing for liquid fuel production. **Different Models** On a study about different models of biogas plants like fixed dome model, floating dome model, RCC digester with flexible gas collector, geo-membrane digester, tube digester, lagoon digester. portable biogas plants, pre-fabricated biogas plants and also the plants constructed at site.	

Suggested Text Books

1.	K .M. Mital, *Biogas Systems: Principles and Applicationsby*, New Age Publishers.
2.	A Chakraverthy, *Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes* by Oxford & IBH publishing Co, 1989.
3.	R. S. Khoiyangbam, Navindu Gupta and Sushil Kumar, *Biogas Technology: Towards Sustainable Development*, The Energy and Resources Institute.
4.	B. T. Nijaguna, *Biogas Technology*, New Age International Publishers.
5.	Georg M. Guebitz, *Biogas Science and Technology*, Springer.
6.	Brad Hill, *Biogas Technology and Principles*, N. Y. Research Press.
7.	Arthur Wellinger, Jerry D. Murphy, David Baxter, *The Biogas Handbook: Science, Production and Applications*, Wood Head Publishing.
8.	Research articles and case studies on Bio-Energy Technologies

Note: Nine questions will be set in all by the examiners taking two questions from each unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

1492

Emerging Technologies in Renewable Energy Sources

PHE-522
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Course Objective: The objective of this course is:

- To explore advanced technologies in renewable energy systems.
- To understand the integration of emerging technologies in sustainable energy solutions.
- To evaluate the performance and efficiency of innovative renewable energy systems.

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

- Analyze emerging technologies in solar, wind, and marine energy systems.
- Evaluate the advancements in biomass, geothermal, and fuel cell technologies.
- Integrate smart grid solutions for efficient renewable energy utilization.
- Critically assess policy frameworks and market trends in renewable energy.

Content

Unit –I	10 Hours
Advanced Solar Energy Technologies Photovoltaic Innovations: Multi-junction solar cells, Perovskite solar cells, Quantum dot photovoltaics; Concentrated Solar Power (CSP): Parabolic trough, Solar tower, Linear Fresnel reflectors, and hybrid CSP systems; Building-Integrated Photovoltaics (BIPV): Smart windows, solar roofs, and transparent PVs; Solar Energy Storage: Thermal energy storage, molten salts, and battery-based systems; Emerging Applications: Solar cooling, solar desalination, and solar water splitting for hydrogen production.	
Unit –II	**10 Hours**
Advanced Wind and Marine Energy Systems Next-Generation Wind Turbines: Vertical-axis wind turbines (VAWT), floating offshore wind turbines, and bladeless wind turbines; Smart Wind Energy Systems: IoT-enabled monitoring, predictive maintenance, and AI in wind energy optimization; Marine Energy: Tidal and wave energy technologies, Oscillating Water Columns (OWC), and underwater kites; Hybrid Systems: Combining wind and wave energy for efficient generation; Challenges and Opportunities: Integration, environmental impacts, and economic feasibility.	
Unit –III	**10 Hours**
Biomass, Geothermal, and Emerging Fuel Technologies Biomass Innovations: Advanced biomass gasification, pyrolysis, and biogas upgrading techniques; Algae-Based Bioenergy: Algal biofuels and bioproducts; Geothermal Energy: Enhanced Geothermal Systems (EGS), closed-loop systems, and geothermal heat pumps; Hydrogen and Fuel Cells: Green hydrogen production, fuel cell technologies, and hydrogen storage solutions; Waste-to-Energy Systems: Advanced incineration, anaerobic digestion, and plasma gasification.	
Unit –IV	**10 Hours**
Smart Grids and Integration of Renewable Energy Smart Grid Technologies: Demand response, real-time monitoring, and energy management systems; Energy Storage Innovations: Solid-state batteries, flow batteries, and flywheels; Microgrids and Distributed Energy Resources (DERs): Architecture, control strategies, and islanding; Artificial Intelligence in Renewable Energy: Predictive analytics, optimization, and fault detection; Policy and Market Trends: Renewable energy policies, carbon credits, and global energy transition strategies.	

Suggested Text Books

1.	Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle
2.	"Handbook of Renewable Energy Technology" by Ahmed F. Zobaa and Ramesh C. Bansal.
3.	"Advanced Renewable Energy Systems" by S. C. Bhatia.
4.	Recent journal papers and case studies in renewable energy technologies.

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Note: Nine questions will be set in all by the examiners taking two questions from each unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

1494

Smart Solar Energy and E-Mobility

PHE-523
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Course Objective: The objective of this course is:

- To explore the integration of solar energy technologies with smart systems.
- To understand the fundamentals and advancements in e-mobility.
- To analyze the challenges and solutions in adopting smart solar energy and electric vehicles.

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

- Understand the advanced solar energy systems and their applications in smart systems.
- Analyze the fundamentals and components of electric mobility systems.
- Evaluate the integration of renewable energy with e-mobility and smart grids.
- Assess challenges and innovations in solar energy and e-mobility for sustainable development.

Content

Unit –I	10 Hours
Advanced Solar Energy Technologies for Smart Systems Solar Photovoltaic Systems: High-efficiency solar panels, bifacial modules, and thin-film technology; Smart Solar Energy Solutions: IoT-based monitoring and control, smart inverters, and solar tracking systems; Solar Energy Storage: Battery integration, hybrid storage systems, and energy management in solar applications; Distributed Solar Energy Systems: Community solar projects and peer-to-peer energy trading; Applications: Solar-powered charging stations, solar rooftops for smart cities, and portable solar devices.	
Unit –II	**10 Hours**
Fundamentals of E-Mobility Electric Vehicle (EV) Basics: Types of EVs (BEVs, PHEVs, FCEVs), components of EVs, and working principles; EV Batteries and Energy Storage: Battery chemistries (Li-ion, solid-state), battery management systems (BMS), and lifecycle analysis; Charging Technologies: AC/DC charging, wireless charging, and fast charging standards (CCS, CHAdeMO); Integration with Renewable Energy: Solar-powered EV charging, grid-tied charging stations, and vehicle-to-grid (V2G) systems; Policy Framework: Government incentives, standards, and regulatory frameworks for EV adoption.	
Unit –III	**10 Hours**
Smart Grids and E-Mobility Integration Smart Grid Basics: Architecture, communication protocols, and demand-side management; Vehicle-to-Grid (V2G) Technology: Bidirectional power flow, grid stabilization, and energy arbitrage; Smart Charging Infrastructure: Load balancing, dynamic pricing, and grid-friendly EV chargers; Renewable Energy Integration: Challenges and solutions in connecting solar power with EV charging networks; Case Studies: Examples of smart grid and EV integration in global markets.	
Unit –IV	**10 Hours**
Challenges, Trends, and Future Directions Challenges in Solar and E-Mobility: Technical, economic, and environmental barriers; Emerging Technologies: Solar-integrated EVs, solid-state batteries, and autonomous electric vehicles; Role of AI and IoT: Predictive maintenance, energy optimization, and user behavior analysis in EVs; Sustainability and Circular Economy: Recycling and reuse of solar panels and EV batteries; Future Trends: Innovations in hybrid renewable systems, policy evolution, and market growth predictions.	

Suggested Text Books

1.	Solar Energy: The Physics and Engineering of Photovoltaic Conversion" by Klaus Jäger et al.
2.	Electric Vehicle Technology Explained" by James Larminie and John Lowry.
3.	Smart Grids: Infrastructure, Technology, and Solutions" by Stuart Borlase.

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4.	Research papers and case studies on solar energy and e-mobility integration.

Note: Nine questions will be set in all by the examiners taking two questions from each unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

1496

Renewable Energy Grid Integration

PHE-524
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Course Objective: The objective of this course is:

- To understand the technical and operational challenges of integrating renewable energy sources into the power grid.
- To study advanced technologies and tools for grid integration.
- To explore the role of energy storage, demand response, and smart grid solutions in renewable energy integration.
- To evaluate the economic, environmental, and policy aspects of renewable energy grid integration.

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

- Understand the fundamentals and challenges of renewable energy grid integration.
- Apply advanced technologies and control strategies to optimize grid performance.
- Evaluate economic and environmental impacts of renewable energy integration.
- Analyze global trends and policy frameworks for effective renewable energy deployment.

Content

Unit –I	08 Hours
Fundamentals of Renewable Energy Grid Integration Overview of Renewable Energy Sources: Solar, wind, hydro, biomass, and geothermal energy; Grid Integration Basics: Role of the grid, grid architecture, and key challenges of renewable energy integration; Variability and Uncertainty: Impact of intermittent renewable sources on grid stability; Power Quality Issues: Voltage stability, frequency regulation, and harmonics; Renewable Energy Penetration Levels: Concept of grid parity and penetration limits.	
Unit –II	**10 Hours**
Technologies for Grid Integration Energy Storage Systems: Battery energy storage, pumped hydro storage, flywheels, and supercapacitors; Power Electronics in Grid Integration: Inverters, converters, and FACTS devices; Grid Interface for Renewables: Interconnection standards, microgrids, and hybrid energy systems; Demand-Side Management: Load forecasting, demand response, and energy efficiency strategies; Case Studies: Examples of successful grid integration of renewable energy.	
Unit –III	**10 Hours**
Smart Grids and Advanced Control Systems Smart Grid Technologies: Real-time monitoring, smart meters, and automated distribution systems; Control Strategies for Renewable Integration: Frequency control, voltage regulation, and active/reactive power control; AI and Machine Learning in Grid Management: Predictive analytics, fault detection, and optimization; Vehicle-to-Grid (V2G) Integration: Role of electric vehicles in grid stabilization; Cybersecurity in Renewable Energy Grids: Protecting grid infrastructure from cyber threats.	
Unit –IV	**10 Hours**
Economic, Environmental, and Policy Perspectives Economic Aspects: Cost-benefit analysis, grid investments, and energy pricing models; Environmental Impact: Carbon footprint reduction, lifecycle analysis of renewable systems, and land use considerations; Policy and Regulatory Frameworks: Renewable energy targets, feed-in tariffs, and net metering policies; Global Case Studies: Best practices from countries with high renewable energy penetration; Future Trends: Role of hydrogen, offshore wind farms, and virtual power plants in grid integration.	

Suggested Text Books

1.	Renewable Energy Integration: Practical Management of Variability, Uncertainty, and Flexibility in Power Grids" by Lawrence E. Jones.

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2.	Smart Grids: Fundamentals of Design and Analysis" by James Momoh
3.	Grid Integration and Dynamic Impact of Wind Energy" by Vijay Vittal.
4.	Research articles and case studies on renewable energy grid integration.

Note: Nine questions will be set in all by the examiners taking two questions from each unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

1498

Integrated/Hybrid Energy Systems

PHE-525
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Course Objective: The objective of this course is:

- To understand the concept and design of integrated/hybrid energy systems (HES).
- To explore the integration of renewable and non-renewable energy sources.
- To analyze the role of advanced technologies in optimizing hybrid energy systems.
- To evaluate economic, environmental, and social impacts of HES.

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

- Understand the principles and components of integrated energy systems.
- Design and optimize hybrid energy systems for specific applications.
- Analyze the role of advanced technologies in enhancing the performance of HES.
- Evaluate the sustainability and scalability of HES for future energy needs.

Content

Unit –I	10 Hours
Fundamentals of Integrated Energy Systems Introduction to Hybrid Energy Systems (HES): Definition, types, and importance of HES; Energy Sources in HES: Solar, wind, biomass, hydro, geothermal, fuel cells, and conventional sources; System Components: Energy generation units, storage systems, power electronics, and control systems; Energy Conversion and Management: Energy flow, conversion efficiency, and load management; Hybrid Configurations: Grid-connected, off-grid, and islanded systems.	
Unit –II	**10 Hours**
Design and Optimization of Hybrid Energy Systems System Design Principles: Sizing of components, system configuration, and load assessment; Optimization Techniques: Simulation tools (HOMER, RETScreen), multi-objective optimization, and techno-economic analysis; Energy Storage in HES: Batteries, pumped hydro, flywheels, hydrogen storage, and thermal energy storage; Control Strategies: Energy management systems, predictive control, and adaptive algorithms; Case Studies: Examples of optimized hybrid systems in rural and urban areas.	
Unit –III	**10 Hours**
Advanced Technologies in HES Smart Grid Integration: Role of smart grids in HES, real-time monitoring, and demand response; IoT and AI Applications: Predictive maintenance, load forecasting, and optimization of energy usage; Hybrid Energy for Microgrids: Architecture, operation, and advantages in localized power systems; Hybrid Renewable Energy Systems (HRES): Solar-wind, solar-biomass, and other renewable combinations; Power Electronics in HES: Inverters, converters, and controllers for efficient energy flow.	
Unit –IV	**10 Hours**
Challenges, Sustainability, and Future Trends Challenges in HES Deployment: Technical, economic, and environmental barriers; Sustainability in HES: Lifecycle analysis, circular economy, and recycling of components; Policy and Regulatory Frameworks: Incentives, standards, and global practices for HES deployment; Emerging Trends: Hydrogen-based hybrid systems, vehicle-to-grid (V2G) integration, and offshore hybrid systems; Global Case Studies: Successful implementations of HES in different regions.	

Suggested Text Books	
1.	Hybrid Renewable Energy Systems: Modelling, Optimization and Control" by B. K. Bose.
2.	"Renewable Energy System Design" by Ziyad Salameh.
3.	"Smart Hybrid AC/DC Microgrids: Advances in Integration and Optimization" by Yunwei Ryan Li and Hui Li.
4.	Research papers and case studies on integrated energy systems and hybrid solutions.

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Note: Nine questions will be set in all by the examiners taking two questions from each unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

1500

Data Warehousing

PHE-526
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Course Objective:

- Develop a Deep Understanding of Data Warehousing Concepts and Architectures.
- Enhance Analytical Skills through Advanced Data Warehousing Techniques.
- Promote Research and Innovation in Data Warehousing.

Course Outcomes:

- Proficiency in Advanced Data Warehousing Techniques
- Ability to Conduct Original Research
- Effective Communication of Research Findings

Content

UNIT- I	12 Hours
Introduction to Data Warehousing: Overview of Data Warehousing Concepts, Evolution of Data Warehousing, Data Warehousing vs. Operational Databases, Data Warehouse Architectures, Star and Snowflake Schemas, Fact and Dimension Tables, Data Modeling Techniques, ETL (Extract, Transform, Load) Processes, Data Integration and Data Cleaning	
UNIT- II	**8 Hours**
Advanced Data Warehousing Techniques: Optimization and Performance, Partitioning, Indexing and Data Organization, Data Aggregation and Summarization, Materialized Views, OLAP and Multidimensional Analysis, OLAP (Online Analytical Processing)MOLAP, ROLAP, and HOLAP Models, Data Warehousing for Business Intelligence	
UNIT- III	**10 Hours**
Data Quality, Security, and Advanced Applications: Data Quality and Metadata Management, Data Quality Management in Data Warehousing, Metadata in Data Warehousing, Data Governance. Data Security Challenges Privacy Preservation Techniques, Regulatory Compliance (e.g., GDPR, HIPAA), Cloud-Based and Real-Time Data Warehousing, Real-Time Data Warehousing, Data Warehouse Appliances.	
UNIT- IV	**16 Hours**
Research Trends and Practical Applications: Research and Future Directions, Recent Advances in Data Warehousing, Research Challenges and Future Directions, Real-World Data Warehousing Projects, Data Visualization and Reporting Tools	

Suggested Text Books

1.	Building the Data Warehouse by W.H. Inmon
2.	The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling" by Ralph Kimball and Margy Ross
3.	Data Warehousing Fundamentals for IT Professionals" by Paulraj Ponniah,
4.	"Data Warehouse Design Solutions" by Christopher Adamson and Michael Venerable

Note: Nine questions will be set in all by the examiners taking two questions from each unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

1501

Robotics and Autonomous Systems

PHE-527 | Total Credits: 4
L T P | Internal Marks: 20
4 0 0 | External Marks: 80
Course Objective: | Total Marks: 100

- Understanding the basic concepts of robotics, including types of robots, components, and their functions.
- Introduction to kinematics and dynamics of robotic systems.
- Exploring algorithms for autonomous navigation, path planning, and decision-making.
- Studying techniques for machine learning and artificial intelligence in autonomous systems.

Course Outcomes:

- Capability to develop and apply algorithms for autonomous navigation, path planning, and decision-making in complex environments.
- Skills to troubleshoot and optimize robotic systems for enhanced performance and reliability.

Content

UNIT- I	12 Hours
Introduction to Robotics: History and Evolution of Robotics. Core Concepts: Kinematics, Dynamics, and Control, Robot Architectures: Hardware and Software. Types of Robots: Mobile Robots, Industrial Robots, Humanoids, etc. Mathematics for Robotics, Linear Algebra and Matrix Theory, Definitions and Principles of Autonomy, Autonomous Systems Architectures. Planning and Decision-Making Algorithms	
UNIT- II	**8 Hours**
Robot Kinematics and Dynamics: Forward and Inverse Kinematics, Robot Dynamics and Control Systems, Motion Planning and Trajectory Generation. Optimization Techniques in Robotics, Machine Learning for Robotics , Computer Vision and Image Processing in Robotics, Natural Language Processing for Human-Robot Interaction. Sensor Data Processing and Fusion Techniques.	
UNIT- III	**10 Hours**
Autonomous Systems and Applications: Autonomous Ground Vehicles (AGVs) and Autonomous Underwater Vehicles (AUVs), Unmanned Aerial Vehicles (UAVs) and Drone Technologies. Real-Time Control and Safety in Autonomous Vehicles, Cooperative Robotics and Multi-Agent Systems, Swarm Intelligence and Distributed Robotics, Communication and Coordination Strategies.	
UNIT- IV	**16 Hours**
Current Research Trends in Robotics and Autonomous Systems: Emerging Technologies in Robotics, Soft Robotics, Bio-Inspired Robotics, Robotics in Manufacturing and Automation. Autonomous Systems in Healthcare, Agriculture, and Defense, Robotics Competitions and Challenges.	

Suggested Text Books

1.	Introduction to Robotics: Mechanics and Control" by John J. Craig
2.	"Probabilistic Robotics" by Sebastian Thrun, Wolfram Burgard, and Dieter Fox.
3.	"Modern Robotics: Mechanics, Planning, and Control" by Kevin M. Lynch and Frank C. Park.
4.	Robotics: Control, Sensing, Vision, and Intelligence" by K.S. Fu, R.C. Gonzalez, and C.S.G. Lee.

Note: Nine questions will be set in all by the examiners taking two questions from eac.h unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

1502

Computer Vision and Applications

PHE-528 | Total Credits: 4
L T P | Internal Marks: 20
4 0 0 | External Marks: 80
| Total Marks: 100

Course Objective:

Understand the basic concepts of computer vision.

- Explore methods for extracting meaningful features from images and video.
- Explore methods for analyzing motion in video.
- To understand the deep learning concept for various computer vision tasks.

Course Outcomes:

- Understand methods for extracting meaningful features of images and video.
- Enhanced the capability of implementing computer vision applications using programming languages like Python.
- Developed practical skills and ethical awareness in the application of computer vision techniques.

Content

UNIT- I	12 Hours
Advanced Satellite remote sensing: Satellite and its classification. Sun synchronous orbit and geostationary orbit, Remote sensing satellites in operation: LANDSAT,SPOT,IRS,INSAT,GEOSAT,IKONOS, QUICK BIRD,NOAA, TERRA their sensor characteristics and application.	
UNIT- II	**8 Hours**
Image and video Enhancement: Algorithms for enhancing image and video quality, denoising, or improving low-light images. Designing systems for analyzing and extracting meaningful information from large image and video datasets. Algorithms for accurate 3D reconstruction from 2D images or video.	
UNIT- III	**10 Hours**
Computer Vision Applications: Computer vision applications for healthcare, robotics, or surveillance. Utilizing image processing techniques for analyzing satellite imagery for environmental monitoring or urban planning. Human-computer interaction using image and video processing.	
UNIT- IV	**16 Hours**
Practical Implementation: Hands-on programming skills in languages like Python, use of popular computer vision libraries such as OpenCV and TensorFlow for implementing algorithms. Ethical considerations related to the use of computer vision, including privacy, bias, and societal implications.	

Suggested Text Books	
1.	Computer Vision: Algorithms and Applications by Richard Szeliski:
2.	Computer Vision: Models, Learning, and Inference" by Simon J.D. Prince, Cambridge University Press
3.	Learning OpenCV 4: Computer Vision with Python, 3rd Edition, by Adrian Kaehler and Gary Bradski,
4.	Computer Vision: Principles, Algorithms, Applications, Learning, by Reinhard Klette, Karsten Schluens, and Andreas Koschan:

Note: Nine questions will be set in all by the examiners taking two questions from each unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

1563

AI Applications in Image and Video Processing

PHE-529
L T P
4 0 0

Total Credits: 4
Internal Marks: 20
External Marks: 80
Total Marks: 100

Course Objective:

Develop a strong foundational knowledge of image and video processing concepts.

- Develop a Fundamental knowledge of techniques, and practical skills related to the application of artificial intelligence.
- Explore methods for extracting meaningful features from images and video.
- Explore methods for analyzing and processing video data.

Course Outcomes:

- Enhanced the Skill of extraction of meaningful information from image and videos using AI.
- Improved video analysis, object tracking, and action recognition skills.
- Enhanced the efficiency and accuracy of medical images analysis.

Content

UNIT- I	12 Hours
Introduction: Developing AI models, analyze and interpret visual information using AI. Identifying relevant features within an image. Identifying and classifying human actions or activities in a video. Utilizing AI model for medical image analysis, disease diagnosis, and personalized treatment recommendations.	
UNIT- II	**8 Hours**
Natural Language Processing (NLP): Improving language understanding, sentiment analysis, and language generation using advanced NLP techniques. Reinforcement Learning in Robotics, applying reinforcement learning for robotic control and decision-making in real-world environments.	
UNIT- III	**10 Hours**
AI and Edge Computing: Integrating AI models into edge devices for real-time processing. AI model for decision-making in resource-constrained environment. Exploring applications of GANs in image synthesis, style transfer, and generating realistic data.	
UNIT- IV	**16 Hours**
AI for Cybersecurity: Developing AI-driven solutions for threat detection, anomaly detection, and cybersecurity risk assessment. AI Ethics and Bias Mitigation: Research on ethical considerations in AI development, methods to mitigate biases in AI algorithms	

Suggested Text Books

1.	Digital Image Processing, by Rafael C. Gonzalez and Richard E. Woods:
2.	Deep Learning, by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
3.	Computer Vision: Models, Learning, and Inference, by Simon J.D. Prince:
4.	Computer Vision: Algorithms and Applications by Richard Szeliski

Note: Nine questions will be set in all by the examiners taking two questions from each unit and one question containing short answer type questions from entire syllabus. Students will be required to attempt five questions, selecting one question from each unit. Question No.1 is compulsory which is from entire syllabus.

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