ANTENNA THEORY AND WIRELESS NETWORK

DSE (Electronics) Sem III
(For Physics and Electronics as core subjects)

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Antenna Theory and Wireless Network Physics DSE 16	**4**	**2**	**0**	**2**	Class XII pass with Physics and Mathematics as main subjects	Basics of digital and analog electronics and communication systems

LEARNING OBJECTIVES

This course gives an overview of wireless communication elements and networks. Students will develop an understanding of basics of antenna, its various parameters, its usage as a transmitter and receiver. Cellular concept and system design fundamentals are described and the evolution of current wireless systems in real world such as 2G, 3G, 4G and LTE networks is discussed.

LEARNING OUTCOMES

At the end of this course, students will be able to achieve the following learning outcomes.
● Identify basic antenna parameter (radiating wire structures).
● Determine directions of maximum signal radiations and the nulls in the radiation patterns. ● Design array antenna systems from specifications.
● Identify the characteristics of radio-wave propagation.
● Identify wireless networks 4G and LTE, and 5G.
● Design cellular systems

THEORY COMPONENT

Unit – I **(14 Hours)**

ANTENNA THEORY
Introduction: Antenna as an element of wireless communication system, antenna radiation mechanism, types of antennas, fundamentals of EMFT: Maxwell's equations and their applications to antennas
Antenna Parameters: Antenna parameters: Radiation pattern (polarization patterns, field and phase patterns), field regions around antenna, radiation parameters (general idea): intensity, beam width, gain, directivity, polarization, bandwidth, efficiency and antenna temperature

Unit – II **(5 Hours)**

Antenna as a transmitter/receiver: Effective height and aperture, power delivered to antenna, input impedance, general idea of radiation from an infinitesimal small current element and radiation from an elementary dipole (Hertzian dipole)

Unit – III **(5 Hours)**

WIRELESS NETWORKS:
Introduction: General idea of cellular and wireless systems, current wireless systems, examples of wireless communication systems, idea about global mobile communication system

Unit – IV **(3 Hours)**

Modern wireless communication systems: General idea 2G,3G and wi-fi, 4G and LTE, and 5G wireless networks, wireless local area networks (WLANs), bluetooth and personal area networks (PANs).

Unit – V **(3 Hours)**

Cellular Concept and System Design Fundamentals: Cellular concept and cellular system fundamentals, cellular systems design considerations (qualitative idea only)

References:
Essential Readings:
1) Antenna Theory, Ballanis, 2nd edition, 2003, John Wiley & Sons
2) Electro Magnetic Waves and Radiating Systems, Jordan and Balmain, E. C., 3rd edition,

1968, Reprint (2003), PHI
3) Fundamentals of Wireless Communication, D. Tse and P. Viswanathan, 2014, Cambridge

University Press
4) Wireless communication and Networks, U. Dalal, 2015, Oxford University Press.
5) Mobile Communication Design and Fundamentals, Lee, William C.Y., 4th edition, 1999

Additional Readings:

1) Wireless communications, A. Goldsmith, 2015, Cambridge University Press 2) Modern Wireless Communication, H. S. and M. M. Pearson, 3rd edition, 2005

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) Study of simple dipole and folded dipole (l/2) antenna, plot and compare the radiation pattern of both antennas.
2) Study of simple dipole 5 element Yagi-UDA and folded dipole 5 element Yagi Uda antenna, plot and compare the radiation pattern of both antennas
3) Study of loop antenna and slot antennas and plot their radiation patterns
4) Study the radiation pattern of ground plane antenna and observe the difference in radiation pattern with single element rod, detector and reflector rods
5) To study the variation of radiated field with distance from transmitting antenna.
6) To study modulation of sine wave on RF transmitted and observe the demodulated wave
on detector receiver
7) Study of the reciprocity theorem for antennas
8) Study the role of matching stub in antenna transmission.
9) To study working of current sensor and measurement of current in various elements of antenna.

10) To study and measure SWR using various types of antennas.
11)To study different parts of a 4G Volte mobile phone and observe constellation diagram for transmitter and receiver IQ signals
12) To study various types of faults in a 4G volte mobile phone.

References for laboratory work:
1) Antenna Theory, Ballanis, 2nd edition, 2003, John Wiley & Sons
2) Fundamentals of Wireless Communication, D. Tse and P. Viswanathan, 2014, Cambridge University Press
3) Mobile Communication Design and Fundamentals, Lee, William C.Y., 4 edition, 1999

PHOTONIC DEVICES AND POWER ELECTRONICS

DSE (Electronics) Sem III
(For Physics and Electronics as core subjects)

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Photonic Devices and Power Electronics Physics DSE 15	**4**	**2**	**0**	**2**	Class XII pass with Physics and Mathematics as main subjects	Analog electronics

LEARNING OBJECTIVES

This paper aims to provide students with in-depth understanding of the principles, concepts, and applications of photonic devices and power electronics. The course covers a range of topics, including, semiconductor lasers, fibre optics, power diodes, power MOSFETs, and power electronics applications. Students will develop the necessary knowledge and skills to design and analyze various photonic and power electronic devices and systems. The course also emphasizes the practical aspects of device design, fabrication, and characterization, preparing students for real-world challenges and opportunities in these fields.

LEARNING OUTCOMES

Upon completion of the course on Photonic Devices and Power Electronics, students are expected to achieve the following learning outcomes.

- Understand the basic principles and concepts of photonic devices and power electronics, including semiconductor lasers, fibre optics, power diodes, power MOSFETs, and power electronics applications.
- Develop the necessary knowledge and skills to design and analyse various photonic and power electronic devices and systems.
- Gain practical experience in device design, fabrication, and characterization.
- Apply the knowledge and skills learned in the course to real-world challenges and opportunities in the fields of photonics and power electronics.
- Develop problem-solving skills, critical thinking skills, and the ability to apply scientific and engineering principles to practical problems.

- Understand the ethical considerations and professional responsibilities associated with the development and use of photonic and power electronic devices and systems.
- Overall, students will gain a comprehensive understanding of photonic devices and power electronics and be well-equipped to pursue careers in these fields or continue their studies at the graduate level.

THEORY COMPONENT

Unit – I (4 Hours)

Classification of photonic devices: Radiative transition and optical absorption. Light Emitting Diodes (construction, materials and operation) Semiconductor LASERs: Condition for amplification, LASER cavity, LASER diode.

Unit – II (8 Hours)

Photodetectors: Photoconductor, photodiodes (p-i-n, avalanche) and phototransistors, quantum efficiency and responsivity
Solar Cell: Construction, working and characteristics.
LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays.

Unit – III (4 Hours)

Introduction to Fiber Optics: Element of an Optical Fiber Transmission link- Optical Fiber Modes and Configurations, Overview of Modes -Single Mode Fibers-Graded Index fiber structure.

Unit – IV (8 Hours)

Power Devices: Need for semiconductor power devices, Power MOSFET (qualitative); introduction to family of thyristors; Silicon Controlled Rectifier (SCR) - structure, I-V characteristics, Turn-On and Turn-Off characteristics, ratings, Gate-triggering circuits; DIAC and TRIAC- Basic structure, working and V-I characteristics

Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switching characteristics, device limitations and safe operating area (SOA)

Unit – V (6 Hours)

Applications of SCR: Phase controlled rectification, AC voltage control using SCR and Triac as a switch. Power Invertors- Need for commutating circuits and their various types, dc link invertors, Parallel capacitor commutated invertors.

References:

Essential Readings:

1) Optoelectronics, J. Wilson and J. F. B. Hawkes, 1996, Prentice Hall India
2) Optoelectronics and Photonics, S. O. Kasap, 2009, Pearson Education

3) Electronic Devices and Circuits, D. A. Bell, 2015, Oxford University Press
4) Introduction to fibre optics, A. K. Ghatak and K. Thyagarajan, 1998, Cambridge

University Press
5) Power Electronics, M. D. Singh and K. B. Khanchandani, Tata McGraw Hill.

Additional Readings:

1) Power Electronics, J. S. Chitode, Technical Publications
2) Basic Electrical and Electronics Engineering, R. Saravanakumar V. Jegathesan and K. V.

Kumar, Wiley
3) Power Electronics: Essentials & Applications, L. Umanand, Wiley

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be performed from the following list

1) Diffraction experiments using a LASER.
2) To determine characteristics of (a) LEDs, (b) Photovoltaic cell and (c) Photodiode.
3) To study the Characteristics of LDR and Photodiode with (i) Variable Illumination intensity, and (ii) Linear Displacement of source.
4) To measure the numerical aperture of an optical fiber.
5) Output and transfer characteristics of a power MOSFET.
6) Study of I-V characteristics of SCR.
7) SCR as a half wave and full wave rectifier with R and R - L loads.
8) AC voltage controller using TRIAC with UJT triggering.
9) Study of I-V characteristics of DIAC.
10) Study of I-V characteristics of TRIAC

References for laboratory work:

1) Power Electronics, P. C. Sen, Tata McGraw Hill. rd
2) Power Electronics Circuits, Devices & Applications, 3 edition, M. H. Rashid, Pearson

Education
3) A Textbook of Electrical Technology, Vol-II, B. L. Thareja and A. K. Thareja, S. Chand.

RESEARCH METHODOLOGY

DSE (Electronics) Sem VI
(For Physics and Electronics as core subjects)

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Research Methodology PHYSICS DSE 13	**4**	**3**	**0**	**1**	Class XII pass with Physics and Mathematics as main subjects	Basic ICT related skills

LEARNING OBJECTIVES

This course has been designed to explore the basic dimensions of research and to impart quantitative and qualitative knowledge for conducting meaningful research. Starting from the philosophy of research, through awareness about the publication ethics and misconducts, this course covers all the methodological and conceptual issues required for a successful conduct of research. It gives an overview of research techniques, data management and analysis, and commonly used statistical methods in physical sciences.

LEARNING OUTCOMES

After successful completion of this course, students will be trained in the following. ● Skills to review literature and frame research problem
● Comprehend the relevance of the tools for data collection and analysis
● Writing a scientific report/research proposal

● Software tools for research in physical sciences ● Research integrity and publication ethics
● Importance of intellectual property rights
● Role of funding agencies in research

SYLLABUS OF Physics DSE - 13

THEORY COMPONENT

Unit - I - Introduction to research methodology (6 Hours)

Brief history of scientific method and research, role and objectives of research, basic tenets of qualitative research; research problem and review of literature: identifying a research problem (philosophy and meaning of research, identification and definition of research problem, formulation of research problem, sources of prejudice and bias); literature survey (open-source and paid tools for keeping track of the literature)

Unit - II - Data collection, analysis and interpretation (15 Hours)

Methods of data collection: survey, interview, observation, experimentation and case study; Descriptive statistics: Measures of central tendency (mean, median, mode) and dispersion (range, standard deviation);
Inferential statistics: Hypothesis testing, Z test, T test; regression analysis (basic concepts of multiple linear regression analysis and theory of attributes); Curve fitting using linear and nonlinear regression (parameter space, gradient search method and Marquardt method); Role of simulation, calibration methods, error analysis, and background handling in experimental design

Unit - III – Journals, Database and Research Metrics (7 Hours)

Journals: Free, open source and paid journals, concept of peer reviewed journals, predatory and fake journals
Databases: Indexing databases; citation databases (Web of science, Scopus); experimental physics databases (astrophysics (ADS, NED, SIMBAD, VizieR), biophysics (PubMed), particle physics (INSPIRE, CDS), condensed matter physics (X-ray database))

Research Metrics: Journal impact factor, SNIP, SJR, IPP, cite score; metrics (h-index, g index, i10 index, altmetrics), variations in research metrics across various disciplines, other limitations of the research metrics and impact factors

Unit - IV – Scientific Conduct and Publication Ethics (8 Hours)

Current understanding of ethics; intellectual honesty and research integrity; communicating errors (erratum, correction and withdrawal); records and logs (maintaining records of samples, raw data, experimental protocols, observation logs, analysis calculations, and codes); scientific publication misconducts: plagiarism (concept, importance, methods and ways to detect and avoid plagiarism) and redundant publications (salami slicing, duplicate and overlapping publications, selective reporting and misrepresentation of data); environmental and other clearances (waste management, disposal of hazardous waste).

COPE guidelines on best practices in publication ethics

Unit V – Scientific Writing and Software Tools (5 Hours)

Writing a research paper and report: introduction, motivation, scientific problem, its methodology, any experimental set up, data analysis, discussion of results, conclusions Referencing formats (APA, MLA) and bibliography management Graphical software (open source, magic plot, gnu plot, origin); presentation tools (beamer)

Unit VI - Intellectual Property Right and Research Funding (4 Hours)

Basic concepts and types of intellectual property (patent, copyright and trademark); Role of funding agencies in research, overview of various funding agencies (DST-SERB, UGC, CSIR, BRNS, DRDO), national and international research project grants and fellowships

References:

Essential Readings:

1) Management Research Methodology, K. N. Krishnaswamy, A. I. Sivakumar, M. Mathirajan, 2006, Pearson Education, New Delhi

2) Research Methodology, Methods and Techniques, C. R. Kothari, 2 edition, 2008, New Age International Publication. th

3) Research Methodology, A step by step guide for beginners, R. Kumar, 6 edition, 2009, Pearson Education

4) Data reduction and error analysis for the physical sciences, P. R. Bevington and D. K. Robinson, 3rd edition, McGraw-Hill

5) Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, C. J. Holland, 2007, Entrepreneur Press

Additional Readings:

1) Research Methods, R. Ahuja, 2001, Rawat Publications, New Delhi.

2) Research design: Qualitative, quantitative, and mixed methods approaches, J. W.

Creswell, and J. D. Creswell, 2017, Sage Publications.

3) Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, A. R. Miller and

M. H. Davis, 2000, West Group Publishers

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

Students should perform at least six practicals from the following list, such that all the units mentioned below are covered.

Unit 1:

1) Identify a research problem, write its brief summary and make a corresponding flowchart

2) Identify a survey-based research problem in physics and create a questionnaire to collect

data to perform meaningful research.
3) Write a literature review for a research problem.
4) Create a list of research topics (at least three) and read at least one research paper in each topic.

Unit 2:

1) Attend a research seminar and write a brief summary in 1000 words. Check the extent of plagiarism in this summary by using on-line plagiarism detection tools
2) Read a research paper based on the use of statistics in experimental physics and summarize its importance.
3) Collect publicly available experimental physics data. Identify the independent, dependent and control variables. Fit at least two mathematical models that can describe the data and compare their statistical significance.

Unit 3:

1) Review any three research papers.
a) List the major strengths and weaknesses of all of them.
b) For any one of these, create a referee report assuming you are a reviewer of the paper. Also draft a response to the referee's report assuming you are the author.
2) Review any research paper. Rewrite it as if the work has been done by you for the first time. Use two different referencing and bibliography styles

Unit 4:

1) Take data from any publicly available experimental physics database. Use Microsoft Office tools (such as chart/bar diagrams, equation editor etc. in Word, PowerPoint or Excel) to present, plot and infer relevant information from the data.

2) Write a scientific synopsis of a research paper using LaTeX.
3) Create a presentation using LaTeX and Beamer on any research topic
4) Select a funding agency and any two schemes or fellowships offered by them. Make a report (using LaTeX) describing the objectives, areas of research support and various components of grants offered by them.