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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**COURSE DESCRIPTION FILE**

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| --- | --- |
| **Academic Year & Semester** | **2018-19, Semester II** |
| **Course Code** | PC602EC |
| **Course Title** | **ANTENNAS AND WAVE PROPAGATION** |
| **Curriculum Regulation** | **CBCS – OU (Affiliated Colleges)** |
| **Semester** | **VI** |
| **Course Instructor** | Mr. I.SRIKANTH, Associate Professor, ECE Department |

1. PREREQUISITE(S):

|  |  |  |  |
| --- | --- | --- | --- |
| **Level** | **Credits** | **Semester** | **Prerequisites** |
| UG | 3 | IV | EMTL |

1. SCHEME OF INSTRUCTIONS

|  |  |  |  |
| --- | --- | --- | --- |
| **Lectures** | **Tutorials** | **Practicals** | **Credits** |
| 3 | 1 | - | 3 |

1. SCHEME OF EVALUATION& GRADING

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No** | **Component** | **Duration** | **Maximum Marks** |
|  | **Continuous Internal Evaluation (CIE)** |  |  |
| 1. | Internal Examination – I | 60 minutes | 20 |
| 2. | Internal Examination - II | 60 minutes | 20 |
|  | Average of the two internal exams |  | **20** |
| 3. | Assignments | - | **5** |
| 4. | Quizzes | - | **5** |
|  | **CIE (Total)** |  | **30** |
| 5. | **Semester End Examination**(University Examination) | 3 hours | **70** |
|  |  | **TOTAL** | **100** |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Marks Range | 85-100 | 70 to < 85 | 60 to < 70 | 55 to < 60 | 50 to < 55 | 40 to < 50 | < 40 | Absent |
| Grade | S | A | B | C | D | E | F | Ab |
| Grade Point | 10 | 9 | 8 | 7 | 6 | 5 | 0 | - |

1. SYLLABUS

|  |  |  |
| --- | --- | --- |
| **Unit** | **Syllabus Description** | **Target****Hours** |
| **I** | Introduction, Fundamental Concepts- Physical concept of radiation, Radiation pattern, Isotropic Radiator, Front–to-back ratio, Antenna Field Regions, Radiation Intensity, Beam Area, Beam Efficiency, Reciprocity, Directivity and Gain, Antenna Apertures, Antenna Polarization, Antenna impedance, Antenna temperature, Friis transmission equation, Retarded potential. | 12 |
| **II** | Current Distributions, Radiation from Infinitesimal Dipole, Half wave Dipole and Quarter wave Monopole, Loop Antennas - Introduction, Small Loop, Far field pattern of circular loop with uniform current, Comparison of far fields of small loop and short dipole, Slot Antennas, Helical Antennas-Helical Geometry, Helix modes, Practical Design considerations for Monofilar Helical Antenna in Axial and Normal Modes, wideband characteristics, radiation efficiency. | 12 |
| **III** | V-antenna, Rhombic Antenna, Yagi-Uda Antenna, Folded Dipoles & their Characteristics, Log-periodic Antenna, Aperture Antennas- Huygens' principle, Radiation from apertures, Babinet's principle, Radiation from Horns and design considerations, Parabolic Reflector and cassegrain Antennas, Lens Antennas, Micro Strip Antennas- Basic characteristics, feeding Methods, Design of Rectangular Patch Antennas, Smart Antennas- Fixed weight Beam Forming basics and Adaptive Beam forming, | 8 |
| **IV** | Array of point sources, two element array with equal and unequal amplitudes, different phases, linear n- element array with uniform distribution, Broadside and End fire arrays, Principle of Pattern Multiplication, Effect of inter element phase shift on beam scanning, Binomial array. **Antenna Measurements:** Introduction, Antenna Test Site and sources of errors, Radiation Hazards, Patterns to be Measured, Radiation, Gain and Impedance Measurement Techniques. | 8 |
| **V** | Ground wave propagation, Space and Surface waves, Troposphere refraction and reflection, Duct propagation, Sky wave propagation, Regular and irregular variations in ionosphere Line of sight propagation. | 8 |
|  | **Total**  | 48 |

**SuggestedReading:**

1. J. D. Kraus, R. J. Marhefka& Ahmad S. Khan, "Antennas and wave Propagation", McGraw-Hill, 4rth Edition, 2010.
2. Constantine A. Balanis, "Antenna Theory: Analysis and Design", Wiley, 3rd edition, 2005
3. Edward C. Jordan and Kenneth G. Balmain, “Electromagnetic Waves and Radiating Systems,” 2/e, PHI, 2001
4. R.E.Collins, Antennas and Radio Propagation, Singapore: McGraw Hill, 1985.
5. 5. R Harish and M. Sachidananda, Antennas and Wave Propagation, Oxford University Press, 2011.
6. E – RESOURCES
7. <https://nptel.ac.in/courses/117107035/>
8. <https://www.youtube.com/channel/UCqZQJ4600a9wIfMPbYc60OQ>
9. COURSE OBJECTIVES:

**Course Overview:**Electronic and Communication Engineering deals with Communicationwhere antenna plays a vital role. This course allows the students to study basic parameters of antenna and understand the principle of radiation. A detailed analysis is done on linear antenna arrays and VHF, UHF antennas. The need for antenna measurements is also emphasized. An introduction to wave propagation and microwave communication is also discussed.

**The objectives of this course are to impart to the following to the students:**

* To familiarize the students with the basic principles of antennas and introduce the antenna terminology.
* To introduce different types of wire antennas and make proficient in analytical skills for understanding practical antennas.
* To familiarize with the design of different types of antennas for various frequency ranges and latest developments in the practical antennas.
* To introduce need for antenna arrays and the concepts of measurements of antennas.
* To introduce the various modes of Radio Wave propagation used.
1. COURSE OUTCOMES

**After completing this course the student will be able to:**

|  |  |  |
| --- | --- | --- |
| **CO No.** | **Course Outcome** | **Taxonomy****Level** |
| 602.1 | **Illustrate** the basic principles of antennas and learn the antenna terminology. | **Understanding** |
| 602.2 | **Design** different types of wire antennas and make proficient in analytical skills for **understanding** practical antennas.  | **Applying** |
| 602.3 | **Design**different types of antennas for various frequency ranges and get updated with latest developments in the practical antennas. | **Creating** |
| 602.4 | **Apply** the principles of antennas, to **design** antenna arrays and measure various parameters of antennas. | **Analysing** |
| 602.5 | **Identify** and **understand** the suitable modes of Radio Wave propagation used in current practice. | **Evaluating** |
| 602.6 | **Analyze** the structure of atmosphere for the wave propagation  | **Analyse** |

1. MAPPING OF COs WITH POs & PSOs

Correlation Level: High – 3; Medium – 2; Low – 1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **PO / CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PS01** | **PSO2** | **PSO3** |
| **C602.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| **C602.2** | 2 | 1 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| **C602.3** | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| **C602.4** | 3 | 2 | - | 2 | - | - | - | - | - | - | - | - | 3 | - | - |
| **C602.5** | 3 | 1 | 1 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| **C602.6** | 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| **C602** | 2.5 | 1.6 | 1.5 | 2 | - | - | - | - | - | - | - | - | 2.6 | - | - |

**Gaps identified based on the mapping:**

1. The syllabus covers theory, concepts and problem solving using fundamental principles related to engineering knowledge only. The Program Outcomes from 5 to 12 are not directly addressed.

**Plan of Action / Corrective measures:**

1. Teaching the antenna concepts through video animations and virtual learning sites, will help in using modern ICT tools in learning the subject effectively. The following websites are provided for the students to watch and learn. This addresses PO5

<https://www.electronics-notes.com/articles/antennas-propagation/>

<http://www.antenna-theory.com/>

<https://www.allaboutcircuits.com/technical-articles/antenna-basics-field-radiation-patterns-permittivity-directivity-gain/>

2. Team work and technical communication is encouraged by giving the student group assignments and group tasks to solve a complex problem in parts.

**Revised Mapping closing the gaps:**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **PO / CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PS01** | **PSO2** | **PSO3** |
| **C602.1** | 3 | 2 | - | - | 1 | - | - | - | 1 | 1 | - | - | 2 | - | - |
| **C602.2** | 2 | 1 | 2 | 2 | 1 | - | - | - | 1 | 1 | - | - | 3 | - | - |
| **C602.3** | 2 | 2 | 2 | 2 | 1 | - | - | - | 1 | 1 | - | - | 3 | - | - |
| **C602.4** | 3 | 2 | - | 2 | 1 | - | - | - | 1 | 1 | - | - | 3 | - | - |
| **C602.5** | 3 | 1 | 1 | - | 1 | - | - | - | 1 | 1 | - | - | 3 | - | - |
| **C602.6** | 2 | 2 | 1 | - | 1 | - | - | - | 1 | 1 | - | - | 2 | - | - |
| **C602** | 2.5 | 1.6 | 1.5 | 2 | 1 | - | - | - | 1 | 1 | - | - | 2.6 | - | - |

**CO-PO/PSO mapping Justification**

Mapped POs& PSOs (Direct): PO1, PO2, PO3, PO4,

Mapped POs& PSOs (Corrective measures): PO5, P09, P10,

**Course outcomes:**

C602.1 :**Illustrate** the basic principles of antennas and learn the antenna terminology. **(Understanding)**

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| --- | --- | --- |
|  | **Mapping Level** | **Justification** |
| **PO1** | 3 | Definitions of all basic antenna parameters such as Radiation pattern, Polarization, Directivity, Gain, Power Beam width are the basic principles and parameters in evaluating the performance of the antenna directly contributing to knowledge. |
| **PO2** | 3 | The above definitions are directly supportive in understanding the problem analysis of antenna.  |
| **PO5** | 1 | Students are encouraged in learning of basic concepts through ICT teaching-Learning resources |
| **PO9** | 1 | Group assignments and tasks |
| **PO10** | 1 | Group assignments and mutual presentations |

C602.2 : **Design** different types of wire antennas and make proficient in analytical skills for **understanding** practical antennas. **(Applying)**

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|  | **Mapping Level** | **Justification** |
| **PO1** | 2 | Applying the physical principle and mathematical formulas for various types of Loop antenna to evaluate its radiation resistances- this directly enhances the engineering knowledge for problem solving. |
| **PO2** | 2 | Directly supportive for problem analysis  |
| **PO3** | 2 | Designing of new antennas considering the real type problems. |
| **PO4** | 2 |  |
| **PO5** | 1 | Students are encouraged in learning of basic concepts through ICT teaching-Learning resources |
| **PO9** | 1 | Group assignments and tasks |
| **PO10** | 1 | Group assignments and mutual presentations |

C602.3: **Design** different types of antennas for various frequency ranges and get updated with latest developments in the practical antennas.**(Creating)**

|  |  |  |
| --- | --- | --- |
|  | **Mapping Level** | **Justification** |
| **PO2** | 2 | Directly dealing with enhancing problem analysis skills  |
| **PO3** | 1 | The above is directly supportive in understanding the problem analysis.. |
| **PO4** | 2 |  |
| **PO5** | 1 | Students are encouraged in learning of basic concepts through ICT teaching-Learning resources |
| **PO9** | 1 | Group assignments and tasks |
| **PO10** | 1 | Group assignments and mutual presentations |

C302.4: **Apply** the principles of antennas, to **design** antenna arrays and measure various parameters of antennas. (**Analyzing)**

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| --- | --- | --- |
|  | **Mapping Level** | **Justification** |
| **PO1** | 3 | Directly contributing to engineering knowledge and analyzing to make appropriate choice of materials in engineering applications |
| **PO2** | 3 | Directly dealing with enhancing problem analysis skills |
| **PO4** | 1 | Forms foundation principles to solve complex problems. |
| **PO5** | 1 | Students are encouraged in learning of basic concepts through ICT teaching-Learning resources |
| **PO9** | 1 | Group assignments and tasks |
| **PO10** | 1 | Group assignments and mutual presentations |

C602.5.**Identify** and **understand** the suitable modes of Radio Wave propagation used in current practice.**(Evaluating)**

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| --- | --- | --- |
|  | **Mapping Level** | **Justification** |
| **PO1** | 3 | Directly enhancing engineering knowledge  |
| **PO2** | 3 | Directly dealing with enhancing problem analysis skills |
| **PO3** | 2 | Encourages comparison of different wave propagation techniques. |
| **PO4** | 2 | Involves interpretation skills from comparison of engineering data. |
| **PO5** | 1 | Students are encouraged in learning of basic concepts through ICT teaching-Learning resources |
| **PO9** | 1 | Group assignments and tasks |
| **PO10** | 1 | Group assignments and mutual presentations |

1. TEACHING-LEARNING METHODOLOGY ADOPTED
2. Chalk and Talk
3. PPTs, Animations and Videos for illustrations
4. Group Assignment.
5. Presentation
6. METHOD OFASSESSMENT OFCOs and POs:

|  |  |  |
| --- | --- | --- |
| Cos | Relevant Pos | Mode of Assessment |
| C602.1-C602.6 | PO1: ENGINEERING KNOWLEDGEPO2: PROBLEM ANALYSISPO3: DESIGN/ DEVELOPMENT OF SOLUTIONSPO4: CONDUCT INVESTIGATION ON COMPLEX PROBLEMSPSO1: PROFESSIONAL COMPETENCE | Assignments, Quizzes, Internal Examinations and External Examination result  |
|  C602.1-C602.6 | PO5: MODERN TOOL USAGE | Exercises to learn through ICT tools and internet websites, Usage of Excel worksheets for problem solving |
| C602.1-C602.6 | PO9: IINDIVIDUAL AND TEAM WORKPO10: COMMUNICATION | Group Assignments, Writing skills in documenting assignments, Presentations |

1. LESSON PLAN:

The course plan is meant as a guideline. There may probably be changes.

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| --- | --- | --- | --- |
| S.No | Topic | No. of periods required | Teaching Methodology |
|  | **UNIT-1** |  |  |
| 1 | Introduction, Fundamental concepts  | 1 | PPT |
| 2 | Physical concept of radiation | 1 | PPT |
| 3 | Radiation pattern, isotropic radiator.  | 1 | PPT |
| 4 | Antenna fields regions, radiation intensity | 1 | BOARD |
| 5 | Beam Area, Beam Efficiency, Reciprocity | 1 | BOARD |
| 6 | Directivity and Gain , Antenna Aperture | 1 | BOARD |
| 7 | Antenna polarization, antenna impedance, antenna temperature | 2 | BOARD |
|  8 | Friis transmission equation, retarded potential | 2 | BOARD |
|  | **UNIT-2** |  |  |
| 10 | Current Distributions | 1 | BOARD |
| 11 | Radiation from Infinitesimal Dipole | 1 | PPT |
| 12 | Half wave Dipole, quarter wave monopole  | 2 | BOARD |
| 13 | Loop Antennas-introduction, small Loop | 1 | BOARD |
| 14 | Far field pattern of circular loop with uniform current | 1 | PPT |
| 15 | Comparison of far fields of small loop and short dipole | 1 | BOARD |
| 16 | Slot antennas | 1 | BOARD |
| 17 | Helical Antennas- helical Geometry, Helix modes | 2 | PPT/ BOARD |
| 18 | Practical design considerations for Monofilar helical Antenna in Axial and Normal Modes. | 2 | BOARD |
|  | **UNIT-3** |  |  |
| 19 | V-antenna, Rhombic Antenna | 1 | PPT |
| 20 | Yagi-Uda Antenna | 1 | PPT |
| 21 | Folded Dipoles & their characteristics | 1 | PPT |
| 22 | Log-Perodic Antenna | 1 | BOARD |
| 23 | Aperture Antennas-Huygens principle, Radiation from apertures | 1 | BOARD |
| 24 | Babinet’s principle | 1 | BOARD |
| 25 | Radiation from Horns and design considerations | 1 | BOARD |
| 26 | Parabolic Reflectors and cassegrain Antennas  | 2 | BOARD |
| 27 | Lens antenna | 1 | BOARD |
| 28 | Micro Strip Antennas- Characteristics , feeding methods | 2 | PPT |
| 29 | Design of rectangular Patch antennas | 1 | BOARD |
| 30 | Smart Antennas-Fixed weight Beam forming basics and Adaptive Beamforming | 2 | BOARD |
|  | **UNIT-4** |  |  |
| 31 | Arrays of pint sources | 1 | BOARD |
| 32 | Two element array with equal amplitudes | 1 | BOARD |
| 33 | Two element array with unequal amplitudes | 1 | BOARD |
| 34 | Different phases Linear n-element array with uniform distribution | 1 | BOARD |
| 35 | Broadside array, End fire arrays | 2 | BOARD |
| 36 | Principle of pattern multiplication | 1 | BOARD |
| 37 | Effect of inter element phase shift on beam scanning | 2 | BOARD |
| 38 | Binomial array , Synthesis of Antenna arrays using Schelkunoff Polynomial method, Woodward-Lawson Method | 2 | BOARD/PPT |
|  | **UNIT-5** |  |  |
| 39 | Ground wave propagation | 1 | BOARD/PPT |
| 40 | Space and surface waves | 1 | BOARD/PPT |
| 41 | Troposphere refraction and reflection | 2 | BOARD/PPT |
| 42 | Duct propagation | 1 | BOARD/PPT |
| 43 | Sky wave propagation | 2 | BOARD/PPT |
| 44 | Regular and irregular variations in ionosphere | 1 | BOARD/PPT |
| 45 | Line of sight propagation | 1 | BOARD/PPT |
|  | **TOTAL CLASSES** | 58 |  |

**Prepared by:** Mr.I.SRIKANTH,Associate Professor, ECE

**Signature:**

**Date :2**1 Dec, 2018

**HOD, EcE**