INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

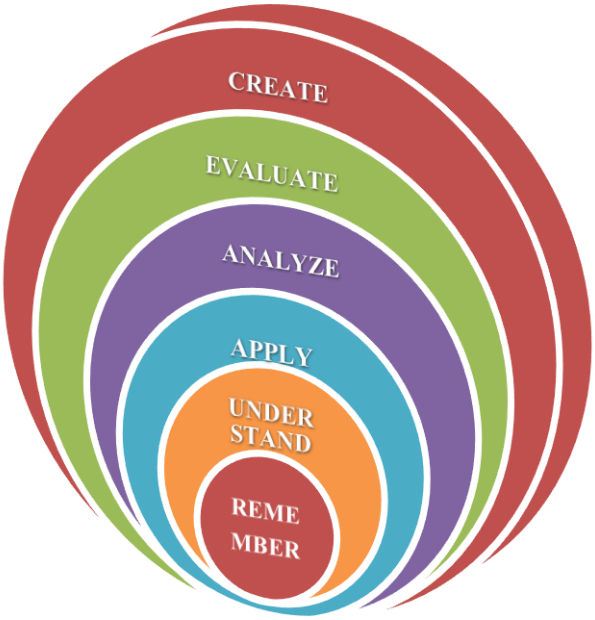
Dundigal - 500 043, Hyderabad

OUTCOME BASED EDUCATION SYSTEM

ELECTRONICS & COMMUNICATION ENGINEERING

B.Tech

2014 – 2018



Vision

To produce professionally competent Electronics and Communication Engineers capable of effectively and efficiently addressing the technical challenges with social responsibility.

Mission

The mission of the Department is to provide an academic environment that will ensure high quality education, training and research by keeping the students abreast of latest developments in the field of Electronics and Communication Engineering aimed at promoting employability, leadership qualities with humanity, ethics, research aptitude and team spirit.

Contents

Program Education Objectives and Outcomes

As Per NBA Norms Post June, 2015

Semester: I, II-I, II-II, III-I, III-II, IV-I & IV-II

Part – I

PROGRAM EDUCATIONAL OBJECTIVES AND OUTCOMES

First version 22 July, 2014

Program Educational Objectives, Program Outcomes and Assessment Criteria (Approved by DAC ECE on 3/9/2014):

Electronics and Communication Engineering Department Advisory Council: The Electronics and Communication Engineering Department Advisory Council (ECEDAC) includes a diverse group of experts from academic and industry, as well as alumni representation. The Advisory Board meets annually, or as needed, for a comprehensive review of the Electronics and Communication Engineering Department strategic planning and programs. The Advisory Council meets with administration, faculty and students and prepares a report, which is presented to principal. In each visit, the Department of Electronics and Communication Engineering responds to the report indicating improvements and amendments to the program.

1. PROGRAM EDUCATIONAL OBJECTIVES, OUTCOMES AND ASSESSMENT CRITERIA

Learning Outcomes, Assessment Criteria

The educational aims of a module are statements of the broad intentions of the teaching team. They indicate the objectives that the teaching team intends to cover and the learning opportunities that are necessary to be available to the student. A learning outcome is a statement that indicates the content that a learner (student) is expected to know, understand and/or be able to do at the end of a period of learning. It is advisable to express learning outcomes with the common prefix:

'On completion of (the period of learning e.g. module), the student is expected to be able to…'

Generally, learning outcomes do not specify curriculum, but more general areas of learning. It is not possible to prescribe precisely how specific a learning outcome statement should be. There is a balance to be struck between the degree of specificity in a learning outcome statement and that achieved by the assessment criteria. If there are too many learning outcomes for a module, then either they are becoming assessment criteria or they are specifying too much curricular detail. The curriculum should be described in the range statement. Too few learning outcomes are unlikely to provide sufficient information on the course. As a guide, there should be between 4 and 8 learning outcomes for a course.

The Program Educational Objectives (PEOs) of the Electronics and Communication Engineering department are broad statements or road maps describing career and professional objectives that intend the graduates to achieve through this program.

2. B. TECH - ELECTRONICS AND COMMUNICATION ENGINEERNIG PROGRAM EDUCATIONAL OBJECTIVES

A graduate of Institute of Aeronautical Engineering in Electronics and Communication Engineering discipline should have a successful career in Electronics and Communication Engineering or a related field, and within three to five years, should attain the following:

PROGRAM EDUCATIONAL OBJECTIVES:

PEO1. Excellence in Career

Student will be successful in professional career by acquiring the knowledge in the fundamentals of Electronics and Communication Engineering principles and professional skills.

PEO2. Professional Effectiveness and Contribution to Society

Student will be in a position to analyze real life problems and design socially accepted and economically feasible solutions in the respective fields.

PEO3. Continuing Education

Student will involve himself in lifelong learning and professional development by pursuing higher education and participation in research and development activities.

PEO4. Exercising Leadership

Student will exhibit good communication skills in their professional career, lead a team with good leadership traits and good interpersonal relationship with the members related to other engineering streams

These objectives are quite broad by intention, as Electronics and Communication Engineering graduates may seek further education or work in diverse areas. To make these objectives meaningful, they may be demonstrated by performance, actions, or achievements.

i. To prepare the students who will be able to attain a solid foundation in Electronics and Communication engineering fundamentals with an attitude to pursue continuing education.

- Make the students to understand their aptitude to choose the correct path of study which leads to higher qualifications and heights in the chosen field.
- Should be prepared to undergo rigorous training in their fields of working.
- Be capable of utilizing the solid foundation obtained at institute to apply successfully in solving the real time engineering problems.
- Students need to have creative thinking processes that are acquired through good training to find solutions to engineering problems.

ii. To prepare the students to function professionally in an increasingly international and rapidly changing world due to the advances in technologies and concepts and to contribute to the needs of the society.

- Adoptability and accommodative mind set to suit modern world and changing economies.
- By working hard in the chosen field and sharing the professional experience at different forums within and outside the country.
- Desirable to be a member of various professional societies (IEEE, IETE, ISTE, IE, and etc.) to keep yourself abreast with the state-of-the-art technology.
- Should continue additional education in a broad range of subjects other than engineering may be needed in order to meet professional challenges efficiently and effectively.
- Continuous interaction with educational and research institutions or industrial research labs.
- Have a sound foundation of knowledge within a chosen field and achieve good depth and experience of practice in it.
- Able to relate knowledge within chosen field to larger problems in society and able to appreciate the interaction between science, technology, and society.
- Strong grasp of quantitative reasoning and an ability to manage complexity and ambiguity.
- To conduct research, and design, develop, test and oversee the development of electronic systems for global upliftment.
- Applying scientific knowledge to solve technical problems and develop products and services that benefit the society.
- An electronic engineer shall contribute to the society by research, design and development, testing and evaluation, application by manufacturing, maintenance by service, management and other functions like sales, customer service and etc.

iii. To prepare the students to acquire and exercise excellent leadership qualities, at various levels appropriate to their experience, to address issues in a responsive, ethical, and innovative manner.

- Gives ample opportunity to work in diverse fields to acquire leadership roles in professional circles outside the workplace.
- Should keep in mind that the opportunities may change with the times.
- Should be prepared for creative solo and collaborative brainstorming sessions.
- Be able to inspire the team with selfless motivation and attitude to achieve success.
- Ability to think laterally or at-least have a flexibility of thought and make choices based on the requirement for situation.

iv. **To prepare the students who will be able to excel, in their careers by being a part of success and growth of an organization, with which they are associated.**

- To achieve this, the focus should not be limited to an engineering curriculum and even to the class room.
- Continuing professional education by attending short term in courses design to update engineering skills.
- A lifelong commitment to learning new and specialized information.
- Should accept first person responsibility and should take the initiative in carrying out the work.
- Should be determined for the duty and dedicated to work and have passion for that.
- Be delight at work with a positive attitude.
- Should be a detailed worker so that one can be relied by the organization.

The department of Electronics and Communication Engineering periodically reviews these objectives and as part of this review process, encourages comments from all interested parties including current students, alumni, prospective students, faculty those who hire or admit our graduates to other programs members of related professional organizations, and colleagues from other educational institutions.

3. B. TECH - ELECTRONICS AND COMMUNICATION ENGINEERNIG PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

A graduate of the Electronics and Communication Engineering Program Outcomes will demonstrate:

PROGRAM OUTCOMES:

PO1. Engineering Knowledge
Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2. Problem Analysis
Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3. Design/Development of Solutions
Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

PO4. Conduct Investigations of Complex Problems
Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Modern Tool Usage

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

PO6. The Engineer and Society

Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

PO7. Environment and Sustainability

Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PO8. Ethics

Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO9. Individual and Team Work

Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO10. Communication

Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

PO11. Life-long Learning

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PO12. Project Management and Finance

Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PROGRAM SPECIFIC OUTCOMES

PSO1. Professional Skills

An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.

PSO2. Problem-solving skills

An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

PSO3. Successful career and Entrepreneurship

An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

4. MAPPING OF PROGRAM EDUCATIONAL OBJECTIVES TO PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

The following Figure shows the correlation between the PEOs and the POs and PSOs

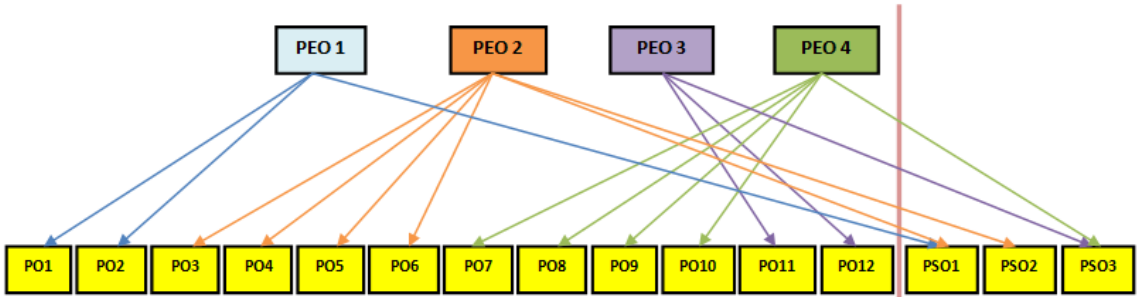


Figure: *Correlation between the PEOs and the POs and PSOs*

The following Table shows the correlation between the Program Educational Objectives and the Program Outcomes & Program Specific Outcomes

	Program Educational Objectives		Program Outcomes & Program Specific Outcomes
I	To be successful in professional career by acquiring the knowledge in the fundamentals of Electronics and Communication Engineering principles and professional skills.	**PO1**	**Engineering Knowledge** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
		PO2	**Problem Analysis** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
		PSO1	**Professional Skills** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems
II	To be in a position to analyze real life problems and design socially accepted and economically feasible solutions in the respective fields.	**PO3**	**Design/Development of Solutions** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the

			cultural, societal, and environmental considerations
		PO4	**Conduct Investigations of Complex Problems** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
		PO5	**Modern Tool Usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
		PO6	**The Engineer and Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
		PSO1	**Professional Skills** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems
		PSO2	**Problem-solving skills** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions
III	To involve themselves in lifelong learning and professional development by pursuing higher education and participation in research and development activities.	**PO11**	**Life-long Learning** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
		PO12	**Project Management and Finance** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
		PSO3	**Successful career and Entrepreneurship** An understanding of social-awareness & environmental-wisdom along with ethical

			responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur
IV	To exhibit good communication skills in their professional career, lead a team with good leadership traits and good interpersonal relationship with the members related to other engineering streams.	**PO7**	**Environment and Sustainability** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
		PO8	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
		PO9	**Individual and Team Work** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
		PO10	**Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
		PSO3	**Successful career and Entrepreneurship** An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur

5. RELATION BETWEEN THE PROGRAM OUTCOMES AND PROGRAM EDUCATIONAL OBJECTIVES

A broad relation between the Program Educational Objectives and the Program Outcomes is given in the following table:

POs ↓ / PEOs →		(1) Excellence in Career	(2) Professional Effectiveness And Contribution to Society	(3) Continuing Education	(4) Exercising Leadership
PO1	Engineering Knowledge			H	
PO2	Problem Analysis			H	

PO3	Design/Development of Solutions		H		S
PO4	Conduct Investigations of Complex Problems	H			H
PO5	Modern Tool Usage		S	S	
PO6	The Engineer and Society		H		S
PO7	Environment and Sustainability		H		H
PO8	Ethics		H		
PO9	Individual and Team work	H		H	
PO10	Communication		H		
PO11	Life-long Learning	S		S	
PO12	Project Management and Finance				S

Relationship between Program Outcomes and Program Educational Objectives
Key: H = Highly Related; S = Supportive

RELATION BETWEEN THE PROGRAM SPECIFIC OUTCOMES AND THE PROGRAM EDUCATIONAL OBJECTIVES

A broad relation between the program Educational Objectives and the Program Specific Outcomes are given in the following table:

PEOs → / PSOs ↓		(1) Excellence in Career	(2) Professional Effectiveness And Contribution to Society	(3) Continuing Education	(4) Exercising Leadership
PSO1	Professional Skills		H		S
PSO2	Problem-solving skills	H		H	S
PSO3	Successful career and Entrepreneurship	S	H	S	

Relationship between Program Specific Outcomes and Program Educational Objectives
Key: H = Highly Related; S = Supportive

Note:

- The assessment process can be direct or indirect.
- The direct assessment will be through interim assessment by the faculty or by industry / technology experts.
- The indirect assessment on the other hand could be by students through course outcomes, lab evaluation, department associations, exit interviews, engineering services, GATE etc.
- Frequency of assessment can be once in a semester and justified by the program coordinator.

6. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES OF (B.Tech) ECE GRADUATES

Graduates from accredited programs must achieve the following learning outcomes, defined by broad areas of learning.

The outcomes are distributed within and among the courses within our curriculum, and our students are assessed for the achievement of these outcomes, as well as specific course learning objectives, through testing, surveys, and other faculty assessment instruments. Information obtained in these assessments is used in a short-term feedback and improvement loop.

Each Electronics and Communication Engineering student will demonstrate the following attributes by the time they graduate:

PO1. Engineering Knowledge

Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

Performance Criteria Definitions

- Identify the concepts and/or equations
- Execute the solution using a logic and structured approach
- Evaluate the solution of the problem

PO2. Problem Analysis

Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

Performance Criteria Definitions

- Identify an engineering problem
- Formulate appropriate theoretical basis for the analysis of a given problem
- Analyze an engineering problem
- Evaluate the appropriate solution to an engineering problem

PO3. Design/Development of Solutions

Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

Performance Criteria Definitions

- Awareness of global effects of the product / practice / event
- Understanding of economic factors
- Awareness of implications to society at large

PO4. Conduct Investigations of Complex Problems

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

Performance Criteria Definitions

- Identify problem/purpose
- Prepare hypothesis

- Outline procedure
- List materials and equipment
- Conduct experiment
- Record observations, data and results
- Perform analysis
- Document conclusions

PO5. Modern Tool Usage

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

Performance Criteria Definitions

- Use modern engineering tools for the system design, simulation and analysis
- Use software applications effectively to write technical reports and oral presentations
- Use modern equipment and instrumentation in the design process, analysis and troubleshooting

PO6. The Engineer and Society

Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

Performance Criteria Definitions

- Informal meetings on current issues
- Participation in public service extracurricular activities
- Required Humanities and Social Sciences (HSS) courses on contemporary issues

PO7. Environment and Sustainability

Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

Performance Criteria Definitions

- Develop a methodology to accomplish the design
- Select a solution from the potential solutions
- Implement the solution

PO8. Ethics

Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

Performance Criteria Definitions

- Demonstrate knowledge of professional code of ethics
- Understanding of ethical and professional issues
- Acknowledge the work of other in a consistent manner
- Exhibit honest behavior

PO9. Individual and Team Work

Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

Performance Criteria Definition

- Research and gather information
- Share responsibilities and duties
- Fulfill team role's duties
- listen to other teammates

PO10. Communication

Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

Performance Criteria Definitions

- Use appropriate format and grammatical structure
- Create a well organized document
- Present the results appropriately
- Demonstrate effective oral communication

PO11. Life-long Learning

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Performance Criteria Definitions

- Find relevant sources of information
- Participate in school or professional seminars
- Participate in students or professional associations

PO12. Project Management and Finance

Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

Performance Criteria Definitions

- Awareness of global effects of the product / practice /event
- Understanding of economic factors
- Awareness of implications to society at large

PROGRAM SPECIFIC OUTCOMES OF (B.Tech) ECE GRADUATES

PSO1. Professional Skills

An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems

Performance Criteria Definitions

- Significantly contributing and delivery of desired engineering component, product or process

- Formulating and solving, moderately complex Electronics and Communication Engineering problems
- Skillful use of state-of-the-art tools for Electronics and Communication Engineering processes
- Making practical recommendations that address issues related to Electronics and Communication Engineering product and systems

PSO2. Problem-solving skills

An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions

Performance Criteria Definitions

- Problem or opportunity identification
- Problem formulation and abstraction
- Information and data collection.
- Model translation
- Experimental design and solution development.
- Implementation and documentation.

PSO3. Successful career and Entrepreneurship

An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur

Performance Criteria Definitions

- Investigate and define a problem and identify constraints relating to health, safety, environmental and sustainability and assessment of risks based on these constraints.
- Understand customer and user needs and the importance of considerations such as aesthetics Identify and manage costs and drivers thereof.
- Use creativity to establish innovative solution Ensure fitness of purpose, for all aspects of the problem including production, operation, maintenance and disposal.
- Manage the design process and evaluate outcomes.

Courses offered in Electronics and Communication Engineering Curriculum (JNTUH-R13) –Vs- Program Outcomes and Program Specific Outcomes Attained through course modules for I, II-I II-II, III-I, III-II, IV-I, IV-II Semesters

Code	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I YEAR																
A10001	English							√						√		
A10002	Mathematics-I	√													√	
A10003	Mathematical Methods	√													√	
A10004	Engineering Physics	√													√	

Code	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
A10005	Engineering Chemistry	√													√	
A10501	Computer Programming			√		√				√		√		√	√	
A10301	Engineering Drawing	√												√		
A10581	Computer Programming Lab			√		√				√		√		√	√	
A10081	Engineering Physics/ Engineering Chemistry Lab	√													√	
A10083	English Language Communication Skills Lab							√							√	
A10082	IT Workshop/ Engineering Workshop			√		√		√		√		√		√		√
									II YEAR I SEMESTER							
A30007	Mathematics - III	√								√		√			√	
A30405	Probability Theory and Stochastic Processes	√	√			√			√			√			√	
A30407	Switching Theory and Logic Design	√	√			√						√	√		√	
A30204	Electrical Circuits	√	√												√	
A30404	Electronic Devices and Circuits	√	√	√		√						√	√	√	√	
A30406	Signals and Systems	√	√			√				√		√		√	√	
A30482	Electronic Devices and Circuits Lab		√	√		√						√			√	
A30481	Basic Simulation Lab		√	√		√						√			√	
									II YEAR II SEMESTER							
A40215	Principles of Electrical Engineering	√	√	√								√	√		√	
A40412	Electronic Circuit Analysis	√	√	√		√				√		√	√		√	
A40415	Pulse and Digital Circuits	√	√	√		√						√	√		√	

Code	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
A40009	Environmental Studies						√		√		√			√		
A40411	Electromagnetic Waves and Transmission Lines	√				√			√	√		√		√	√	√
A40410	Digital Design using Verilog HDL		√							√	√	√	√		√	√
A40288	Electrical Technology Lab.		√	√		√						√	√		√	
A40484	Electronic Circuits and Pulse Circuits Lab.		√	√		√				√		√	√		√	
III YEAR I SEMESTER																
A50217	Control Systems Engineering	√				√						√	√		√	
A50516	Computer Organization and Operating Systems			√						√		√	√	√		
A50418	Antennas and Wave Propagation	√	√			√				√		√	√		√	√
A50422	Electronic Measurements and Instrumentation	√	√	√						√		√	√		√	
A50408	Analog Communications	√	√			√				√		√	√	√	√	
A50425	Integrated Circuits Applications	√	√	√		√				√		√	√	√	√	
A50482	Analog Communications Lab		√			√				√		√	√		√	
A50488	IC Applications and HDL Simulation Lab.		√	√		√				√		√	√		√	
III YEAR II SEMESTER																
A60010	Managerial Economics and Financial Analysis	√			√				√					√		
	Open Elective:															
A60018	Human Values and Professional Ethics			√	√		√				√				√	
A60117	Disaster Management										√					
	Intellectual Property			√		√					√	√			√	

Code	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
A60017	Rights								√						√	
A60420	Digital Communications	√	√	√		√				√	√	√	√	√	√	
A60432	VLSI Design	√	√	√		√					√	√	√	√	√	√
A60430	Microprocessors and Microcontrollers		√	√						√	√	√	√		√	√
A60421	Digital Signal Processing	√	√	√		√		√		√		√	√		√	√
A60494	Microprocessors and Microcontrollers Lab.		√	√		√						√	√		√	
A60493	Digital Signal Processing Lab.		√	√		√						√	√		√	
IV YEAR I SEMESTER																
A70014	Management Science				√		√	√	√					√		
A47044	Microwave Engineering	√	√	√		√				√	√	√	√		√	√
A70515	Computer Networks								√	√			√	√		
A70434	Cellular and Mobile Communications			√		√		√			√	√	√		√	√
	Elective-I															
A70436	Digital Image Processing	√	√	√		√			√	√		√	√		√	√
A70443	Multimedia and Signal Coding		√									√		√		
A70505	Object Oriented Programming through Java			√			√							√		
	Elective-II															
A70447	Television Engineering			√		√			√			√		√		
A70444	Optical Communications	√	√	√		√					√	√	√	√		
A70440	Embedded Systems Design		√			√			√					√		
A70086	Advanced Communication Skills Lab.							√						√		
A70499	Microwave Engineering and		√	√		√						√	√		√	√

Code	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	Digital Communications Lab.															
	IV YEAR II SEMESTER															
	Elective-III:															
A80452	Satellite Communications	√	√	√		√				√			√	√		√
A81102	Biomedical Instrumentation	√	√	√	√								√	√	√	
A80527	Artificial Neural Networks	√	√	√		√					√				√	
	Elective-IV:															
A80431	Telecommunication Switching Systems and Networks	√		√		√			√		√	√	√	√		√
A80450	Radar Systems	√	√			√			√	√	√		√	√	√	√
A80449	Network Security	√		√					√	√	√		√	√		√
	Elective-V:															
A80454	Wireless Communications and Networks		√	√		√					√	√	√		√	√
A80437	Digital Signal Processors and Architectures	√	√	√						√	√	√		√	√	
A80451	RF Circuit Design		√			√				√					√	√
A80087	Industry Oriented Mini Project			√	√			√							√	√
A80089	Seminar			√				√						√		
A80088	Major Project			√	√			√						√		√
A80090	Comprehensive Viva							√						√	√	

7. PROCEDURES FOR OUTCOME DELIVERY AND ASSESSMENT WITH RESPECT TO PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

The categorization of outcomes of the above Electronics and Communication Engineering courses is grouped as follows:

The Courses covered by Individual Program Outcomes and Program Specific Outcomes

PO1: Engineering Knowledge **Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems**			
A10002	Mathematics - I	A10003	Mathematical Methods
A10301	Engineering Drawing	A10501	Computer programming
A10004	Engineering Physics	A10081	Engineering Physics and Engineering

			Chemistry Lab
A10005	Engineering Chemistry	A10581	Computer programming lab
A30204	Electrical Circuits	A30406	Signals and Systems
A30007	Mathematics - III	A30405	Probability Theory and Stochastic Processes
A30404	Electronic Devices and Circuits	A30407	Switching Theory and Logic Design
A40215	Principles of Electrical Engineering	A40410	Digital Design using Verilog HDL
A40415	Pulse and Digital Circuits	A40411	Electromagnetic Waves and Transmission Lines
A40412	Electronic Circuit Analysis	A50217	Control Systems
A50422	Electronic Measurements and Instrumentation	A50408	Analog Communications
A50425	Linear and Digital IC applications	A50418	Antennas and Wave Propagation
A60420	Digital Communications	A60430	Microprocessors and Microcontrollers
A60421	Digital Signal Processing	A60010	Managerial Economics and Financial Analysis
A60432	VLSI Design	A70434	Cellular and Mobile Communications
A70442	Microwave Engineering	A70443	Multimedia and Signal Coding
A70436	Digital Image Processing	A70444	Optical Communications
A80527	Artificial Neural Networks	A80451	RF Circuit Design
A80449	Network Security	A80452	Satellite Communications

PO2: Problem Analysis

Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

A10002	Mathematics - I	A10003	Mathematical Methods
A10301	Engineering Drawing	A10501	Computer programming
A10004	Engineering Physics	A10081	Engineering Physics and Engineering Chemistry Lab
A10005	Engineering Chemistry	A10581	Computer programming lab
A30204	Electrical Circuits	A30406	Signals and Systems
A30007	Mathematics - III	A30405	Probability Theory and Stochastic Processes
A30404	Electronic Devices and Circuits	A30407	Switching Theory and Logic Design
A30482	Electronic Devices and Circuits Lab	A30481	Basic Simulation lab
A40215	Principles of Electrical Engineering	A40410	Digital Design using Verilog HDL
A40415	Pulse and Digital Circuits	A40411	Electromagnetic Waves and Transmission Lines
A40484	Electronic Circuits Lab	A40412	Electronic Circuit Analysis
A50422	Electronic Measurements and Instrumentation	A50217	Control Systems
A50425	Linear and Digital IC applications	A50408	Analog Communications
A50482	AC communications lab	A50418	Antennas and Wave Propagation
A60420	Digital Communications	A50488	IC Applications & HDL Simulation lab
A60421	Digital Signal Processing	A60430	Microprocessors and Microcontrollers
A60494	Microprocessors and Microcontrollers Lab	A60010	Managerial Economics and Financial Analysis
A60493	Digital Signal Processing Lab	A60432	VLSI Design

A70442	Microwave Engineering	A70434	Cellular and Mobile Communications
A70436	Digital Image Processing	A70443	Multimedia and Signal Coding
A70440	Embedded Systems Design	A70444	Optical Communications
A80527	Artificial Neural Networks	A70499	Microwave Engineering and Digital Communications Lab
A80449	Network Security	A80451	RF Circuit Design
A80431	Telecommunication Switching Systems and Networks	A80452	Satellite Communications
A80437	Digital Signal Processors and Architectures	A80450	Radar Systems

PO3: Design/Development of Solutions **Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations**			
A10501	Computer programming	A10581	Computer programming lab
A10081	Engineering Physics and Engineering Chemistry Lab	A30406	Signals and Systems
A30204	Electrical Circuits	A30405	Probability Theory and Stochastic Processes
A30404	Electronic Devices and Circuits	A30407	Switching Theory and Logic Design
A30482	Electronic Devices and Circuits Lab	A30481	Basic Simulation lab
A40215	Principles of Electrical Engineering	A40410	Digital Design using Verilog HDL
A40415	Pulse and Digital Circuits	A40411	Electromagnetic Waves and Transmission Lines
A40484	Electronic Circuits Lab	A40412	Electronic Circuit Analysis
A40288	Electrical Technology lab	A50516	Computer Organization and Operating Systems
A50422	Electronic Measurements and Instrumentation	A50217	Control Systems
A50425	Linear and Digital IC applications	A50408	Analog Communications
A50482	AC communications lab	A50418	Antennas and Wave Propagation
A60420	Digital Communications	A50488	IC Applications & HDL Simulation lab
A60421	Digital Signal Processing	A60430	Microprocessors and Microcontrollers
A60494	Microprocessors and Microcontrollers Lab	A60010	Managerial Economics and Financial Analysis
A60493	Digital Signal Processing Lab	A60432	VLSI Design
A60018	Human Values and Professional Ethics	A60117	Disaster Management
A60017	Intellectual Property Rights	A70014	Management Science
A70442	Microwave Engineering	A70434	Cellular and Mobile Communications
A70436	Digital Image Processing	A70443	Multimedia and Signal Coding
A70440	Embedded Systems Design	A70444	Optical Communications
A70515	Computer Networks	A70505	Object Oriented Programming through Java
A80527	Artificial Neural Networks	A70499	Microwave Engineering and Digital Communications Lab
A80449	Network Security	A80451	RF Circuit Design
A80431	Telecommunication Switching Systems	A80452	Satellite Communications

	and Networks		
A80437	Digital Signal Processors and Architectures	A80450	Radar Systems
A80087	Industry Oriented Mini Project	A80088	Major Project
A80089	Seminar	A80090	Comprehensive Viva

PO4: Conduct Investigations of Complex Problems **Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions**			
A30204	Electrical Circuits	A30406	Signals and Systems
A30007	Mathematics - III	A30405	Probability Theory and Stochastic Processes
A30404	Electronic Devices and Circuits	A30407	Switching Theory and Logic Design
A30482	Electronic Devices and Circuits Lab	A30481	Basic Simulation lab
A40215	Principles of Electrical Engineering	A40410	Digital Design using Verilog HDL
A40415	Pulse and Digital Circuits	A40411	Electromagnetic Waves and Transmission Lines
A40484	Electronic Circuits Lab	A40412	Electronic Circuit Analysis
A50422	Electronic Measurements and Instrumentation	A50217	Control Systems
A50425	Linear and Digital IC applications	A50408	Analog Communications
A50482	AC communications lab	A50418	Antennas and Wave Propagation
A60420	Digital Communications	A50488	IC Applications & HDL Simulation lab
A60421	Digital Signal Processing	A60430	Microprocessors and Microcontrollers
A60494	Microprocessors and Microcontrollers Lab	A60010	Managerial Economics and Financial Analysis
A60493	Digital Signal Processing Lab	A60432	VLSI Design
A70442	Microwave Engineering	A70434	Cellular and Mobile Communications
A70436	Digital Image Processing	A70443	Multimedia and Signal Coding
A70440	Embedded Systems Design	A70444	Optical Communications
A80527	Artificial Neural Networks	A70499	Microwave Engineering and Digital Communications Lab
A80449	Network Security	A80451	RF Circuit Design
A80431	Telecommunication Switching Systems and Networks	A80452	Satellite Communications
A80437	Digital Signal Processors and Architectures	A80450	Radar Systems

PO5: Modern Tool Usage **Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations**			
A30204	Electrical Circuits	A30406	Signals and Systems
A30007	Mathematics - III	A30405	Probability Theory and Stochastic Processes
A30404	Electronic Devices and Circuits	A30407	Switching Theory and Logic Design
A30482	Electronic Devices and Circuits Lab	A30481	Basic Simulation lab

A40215	Principles of Electrical Engineering	A40410	Digital Design using Verilog HDL
A40415	Pulse and Digital Circuits	A40411	Electromagnetic Waves and Transmission Lines
A40484	Electronic Circuits Lab	A40412	Electronic Circuit Analysis
A50422	Electronic Measurements and Instrumentation	A50217	Control Systems
A50425	Linear and Digital IC applications	A50408	Analog Communications
A50482	AC communications lab	A50418	Antennas and Wave Propagation
A60420	Digital Communications	A50488	IC Applications & HDL Simulation lab
A60421	Digital Signal Processing	A60430	Microprocessors and Microcontrollers
A60494	Microprocessors and Microcontrollers Lab	A60010	Managerial Economics and Financial Analysis
A60493	Digital Signal Processing Lab	A60432	VLSI Design
A70442	Microwave Engineering	A70434	Cellular and Mobile Communications
A70436	Digital Image Processing	A70443	Multimedia and Signal Coding
A70440	Embedded Systems Design	A70444	Optical Communications
A80527	Artificial Neural Networks	A70499	Microwave Engineering and Digital Communications Lab
A80431	Telecommunication Switching Systems and Networks	A80452	Satellite Communications
A80437	Digital Signal Processors and Architectures	A80450	Radar Systems
A80449	Network Security	A80451	RF Circuit Design

PO6: The Engineer and Society **Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice**			
A80087	Industry Oriented Mini Project	A80088	Major Project
A40009	Environmental Studies	A60117	Disaster Management
A60018	Human Values and Professional Ethics	A70014	Management Science
A60017	Intellectual Property Rights	A80090	Comprehensive Viva
A80089	Seminar		

PO7: Environment and Sustainability **Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development**			
A10501	Computer programming	A10581	Computer programming lab
A10081	Engineering Physics and Engineering Chemistry Lab	A30406	Signals and Systems
A30204	Electrical Circuits	A30405	Probability Theory and Stochastic Processes
A30404	Electronic Devices and Circuits	A30407	Switching Theory and Logic Design
A30482	Electronic Devices and Circuits Lab	A30481	Basic Simulation lab
A40215	Principles of Electrical Engineering	A40410	Digital Design using Verilog HDL
A40415	Pulse and Digital Circuits	A40411	Electromagnetic Waves and Transmission Lines
A40484	Electronic Circuits Lab	A40412	Electronic Circuit Analysis

A40288	Electrical Technology lab	A50516	Computer Organization and Operating Systems
A50422	Electronic Measurements and Instrumentation	A50217	Control Systems
A50425	Linear and Digital IC applications	A50408	Analog Communications
A50482	AC communications lab	A50418	Antennas and Wave Propagation
A60420	Digital Communications	A50488	IC Applications & HDL Simulation lab
A60421	Digital Signal Processing	A60430	Microprocessors and Microcontrollers
A60494	Microprocessors and Microcontrollers Lab	A60010	Managerial Economics and Financial Analysis
A60493	Digital Signal Processing Lab	A60432	VLSI Design
A60018	Human Values and Professional Ethics	A60117	Disaster Management
A60017	Intellectual Property Rights	A70014	Management Science
A70442	Microwave Engineering	A70434	Cellular and Mobile Communications
A70436	Digital Image Processing	A70443	Multimedia and Signal Coding
A70440	Embedded Systems Design	A70444	Optical Communications
A70515	Computer Networks	A70505	Object Oriented Programming through Java
A80527	Artificial Neural Networks	A70499	Microwave Engineering and Digital Communications Lab
A80449	Network Security	A80451	RF Circuit Design
A80431	Telecommunication Switching Systems and Networks	A80452	Satellite Communications
A80437	Digital Signal Processors and Architectures	A80450	Radar Systems
A80087	Industry Oriented Mini Project	A80088	Major Project
A80089	Seminar	A80090	Comprehensive Viva

PO8: Ethics **Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice**			
A40009	Environmental Studies	A60117	Disaster Management
A60018	Human Values and Professional Ethics	A60017	Intellectual Property Rights

PO9: Individual and Team Work **Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings**			
A80087	Industry Oriented Mini Project	A80088	Major Project
A40009	Environmental Studies	A60117	Disaster Management
A60018	Human Values and Professional Ethics	A70014	Management Science
A60017	Intellectual Property Rights	A60010	Managerial Economics and Financial Analysis
A80089	Seminar	A81102	Biomedical Instrumentation

PO10: Communication **Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions**			
A10083	English Language Communication skill Lab	A10001	English
A60018	Human Values and Professional Ethics	A70086	Advanced Communications Skills Lab
A80087	Industry Oriented Mini Project	A80088	Major Project
A80089	Seminar	A80090	Comprehensive Viva

PO11: Life-long Learning **Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change**			
A10501	Computer programming	A30406	Signals and Systems
A30204	Electrical Circuits	A30405	Probability Theory and Stochastic Processes
A30404	Electronic Devices and Circuits	A30407	Switching Theory and Logic Design
A30482	Electronic Devices and Circuits Lab	A30481	Basic Simulation lab
A40215	Principles of Electrical Engineering	A40410	Digital Design using Verilog HDL
A40415	Pulse and Digital Circuits	A40411	Electromagnetic Waves and Transmission Lines
A40484	Electronic Circuits Lab	A40412	Electronic Circuit Analysis
A40288	Electrical Technology lab	A50217	Control Systems
A50422	Electronic Measurements and Instrumentation	A50408	Analog Communications
A50425	Linear and Digital IC applications	A50418	Antennas and Wave Propagation
A50482	AC communications lab	A50488	IC Applications & HDL Simulation lab
A60420	Digital Communications	A60430	Microprocessors and Microcontrollers
A60421	Digital Signal Processing	A60432	VLSI Design
A60494	Microprocessors and Microcontrollers Lab	A70434	Cellular and Mobile Communications
A60493	Digital Signal Processing Lab	A70443	Multimedia and Signal Coding
A70442	Microwave Engineering	A70444	Optical Communications
A70436	Digital Image Processing	A80450	Radar Systems
A70440	Embedded Systems Design	A80451	RF Circuit Design
A80527	Artificial Neural Networks	A80452	Satellite Communications
A80449	Network Security	A80437	Digital Signal Processors and Architectures
A80431	Telecommunication Switching Systems and Networks		

PO12: Project Management and Finance **Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments**			
A10501	Computer programming	A10581	Computer programming lab
A10081	Engineering Physics and Engineering Chemistry Lab	A30406	Signals and Systems

A30204	Electrical Circuits	A30405	Probability Theory and Stochastic Processes
A30404	Electronic Devices and Circuits	A30407	Switching Theory and Logic Design
A30482	Electronic Devices and Circuits Lab	A30481	Basic Simulation lab
A40215	Principles of Electrical Engineering	A40410	Digital Design using Verilog HDL
A40415	Pulse and Digital Circuits	A40411	Electromagnetic Waves and Transmission Lines
A40484	Electronic Circuits Lab	A40412	Electronic Circuit Analysis
A40288	Electrical Technology lab	A50516	Computer Organization and Operating Systems
A50422	Electronic Measurements and Instrumentation	A50217	Control Systems
A50425	Linear and Digital IC applications	A50408	Analog Communications
A50482	AC communications lab	A50418	Antennas and Wave Propagation
A60420	Digital Communications	A50488	IC Applications & HDL Simulation lab
A60421	Digital Signal Processing	A60430	Microprocessors and Microcontrollers
A60494	Microprocessors and Microcontrollers Lab	A60010	Managerial Economics and Financial Analysis
A60493	Digital Signal Processing Lab	A60432	VLSI Design
A60018	Human Values and Professional Ethics	A60117	Disaster Management
A60017	Intellectual Property Rights	A70014	Management Science
A70442	Microwave Engineering	A70434	Cellular and Mobile Communications
A70436	Digital Image Processing	A70443	Multimedia and Signal Coding
A70440	Embedded Systems Design	A70444	Optical Communications
A70515	Computer Networks	A70505	Object Oriented Programming through Java
A80527	Artificial Neural Networks	A70499	Microwave Engineering and Digital Communications Lab
A80449	Network Security	A80451	RF Circuit Design
A80431	Telecommunication Switching Systems and Networks	A80452	Satellite Communications
A80437	Digital Signal Processors and Architectures	A80450	Radar Systems

PSO1: Professional Skills

An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems

A10001	English	A10082	IT Workshop/ Engineering Workshop
A10501	Computer Programming	A30404	Electronic Devices and Circuits
A10301	Engineering Drawing	A30406	Signals and Systems
A10581	Computer Programming Lab	A40009	Environmental Studies
A50516	Computer Organization and Operating Systems	A40411	Electromagnetic Waves and Transmission Lines
A50408	Analog Communications	A60010	Managerial Economics and Financial Analysis
A50425	Integrated Circuits Applications	A60420	Digital Communications
A70014	Management Science	A60432	VLSI Design

A70515	Computer Networks	A70443	Multimedia and Signal Coding
A70505	Object Oriented Programming through Java	A70444	Optical Communications
A70447	Television Engineering	A70440	Embedded Systems Design
A70086	Advanced Communication Skills Lab.	A81102	Biomedical Instrumentation
A80452	Satellite Communications	A80450	Radar Systems
A80431	Telecommunication Switching Systems and Networks	A80449	Network Security
A80089	Seminar	A80437	Digital Signal Processors and Architectures
A80088	Major Project	A80090	Comprehensive Viva

PSO2: Problem-solving skills **An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions**			
A10002	Mathematics-I	A10082	IT Workshop/ Engineering Workshop
A10003	Mathematical Methods	A10081	Engineering Physics/ Engineering Chemistry Lab
A10004	Engineering Physics	A10083	English Language Communication Skills Lab
A10005	Engineering Chemistry	A30482	Electronic Devices and Circuits Lab
A30007	Mathematics - III	A30481	Basic Simulation Lab
A30405	Probability Theory and Stochastic Processes	A60018	Human Values and Professional Ethics
A30407	Switching Theory and Logic Design	A60117	Disaster Management
A30204	Electrical Circuits	A60017	Intellectual Property Rights
A10501	Computer Programming	A30404	Electronic Devices and Circuits
A10581	Computer Programming Lab	A30406	Signals and Systems
A40215	Principles of Electrical Engineering	A50217	Control Systems Engineering
A40412	Electronic Circuit Analysis	A50418	Antennas and Wave Propagation
A40415	Pulse and Digital Circuits	A50422	Electronic Measurements and Instrumentation
A60430	Microprocessors and Microcontrollers Lab.	A80527	Artificial Neural Networks
A60421	Digital Signal Processing	A70499	Microwave Engineering and Digital Communications Lab.
A60494	Microprocessors and Microcontrollers Lab.	A50408	Analog Communications
A60493	Digital Signal Processing Lab.	A50425	Integrated Circuits Applications
A40411	Electromagnetic Waves and Transmission Lines	A50482	Analog Communications Lab
A40410	Digital Design using Verilog HDL	A50488	IC Applications and HDL Simulation Lab.
A40288	Electrical Technology Lab.	A70434	Cellular and Mobile Communications
A40484	Electronic Circuits and Pulse Circuits Lab.	A60010	Managerial Economics and Financial Analysis
A47044	Microwave Engineering	A60420	Digital Communications

A50408	Analog Communications	A60432	VLSI Design
A50425	Integrated Circuits Applications	A70443	Multimedia and Signal Coding
A70014	Management Science	A70444	Optical Communications
A70436	Digital Image Processing	A70440	Embedded Systems Design
A70505	Object Oriented Programming through Java	A81102	Biomedical Instrumentation
A70447	Television Engineering	A80450	Radar Systems
A70086	Advanced Communication Skills Lab.	A80087	Industry Oriented Mini Project
A81102	Biomedical Instrumentation	A80437	Digital Signal Processors and Architectures
A80454	Wireless Communications and Networks	A80090	Comprehensive Viva
A80451	RF Circuit Design		

PSO3: Successful career and Entrepreneurship

An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur

A60430	Microprocessors and Microcontrollers Lab.	A10082	IT Workshop/ Engineering Workshop
A60421	Digital Signal Processing	A50418	Antennas and Wave Propagation
A80527	Artificial Neural Networks	A60493	Digital Signal Processing Lab.
A60494	Microprocessors and Microcontrollers Lab.	A70499	Microwave Engineering and Digital Communications Lab.
A40411	Electromagnetic Waves and Transmission Lines	A80449	Network Security
A80431	Telecommunication Switching Systems and Networks	A70434	Cellular and Mobile Communications
A47044	Microwave Engineering	A80088	Major Project
A80452	Satellite Communications	A60010	Managerial Economics and Financial Analysis
A70014	Management Science	A60420	Digital Communications
A70436	Digital Image Processing	A60432	VLSI Design
A70505	Object Oriented Programming through Java	A70443	Multimedia and Signal Coding
A70447	Television Engineering	A70444	Optical Communications
A70086	Advanced Communication Skills Lab.	A70440	Embedded Systems Design
A81102	Biomedical Instrumentation	A81102	Biomedical Instrumentation
A80454	Wireless Communications and Networks	A80450	Radar Systems
A80451	RF Circuit Design	A80087	Industry Oriented Mini Project

8. METHODS OF MEASURING LEARNING OUTCOMES AND VALUE ADDITION

There are many different ways to assess student learning. In this section, we present the different types of assessment approaches available and the different frameworks to interpret the results.

i. Mid Semester Course Evaluation
ii. End-of Semester Course Evaluation
iii. Continuous Evaluation of Classroom Performance
iv. Course Objective Surveys
v. Course Instructor's Evaluations
vi. Graduating Senior's survey
vii. Alumni Survey
viii. Employer Survey
ix. Laboratory and Project Works
x. Balanced Composition in Curriculum
xi. Department Academic Committee and Faculty Meetings
xii. Professional Societies

The above assessment indicators are detailed below.

i. Mid Semester Course Evaluation

Mid semester course reviews are conducted for all courses by the department. All students are encouraged to actively participate in this evaluation process. These evaluations are critically reviewed by HOD and senior faculty and the essence is communicated to the faculty concerned to analyze, improve and practice so as to improve the performance of the student.

ii. End-of Semester Course Evaluation

The end-of semester course reviews are conducted, feedback taken from students and remedial measures will be taken up such that the student gets benefited before going for the university end exams. The positive and negative comments made by the students about the course are recorded and submitted to the departmental academic council (DAC) and to the Principal for taking necessary actions to better the course for subsequent semesters.

iii. Continuous Evaluation of Classroom Performance

Students are encouraged and motivated to participate actively in the classroom proceedings by way of interactive teaching by the instructor. Surprise class tests comprising of short answer questions, quiz based discussions, multiple-choice, true-false, and matching tests are conducted to strengthen the teaching-learning process. Apart from teacher control and covering content, the teacher also acts as a felicitator and students discover things for themselves, enabling them to be more independent and becoming life-long learners exploring student-centric educational philosophy.

iv. Course Objective Surveys

Students are encouraged to fill-out a brief survey on the fulfillment of course objectives. The data is reviewed by the concerned course faculty and the results are kept open for the entire faculty. Based on this, alterations or changes to the course objectives are undertaken by thorough discussions in faculty and DAC meetings.

v. Course Instructor's Evaluations

The course coordinator will collect the course portfolios from the respective instructors of each course offered in a given semester at the beginning of the semester as well as at the end of the semester. They remain on file for verification and study by the entire faculty. This helps the course coordinator and faculty to understand how effectively we can teach the given course. Betterment can be achieved from time to time and continuous improvement can be shown in handling courses in the subsequent semesters.

vi. Graduating Senior's Survey

The graduating senior's survey form is to be filled by all the students leaving the institution. The questionnaire is designed in such a way to gather information from the students regarding the program educational objectives, solicit about program experiences, carrier choices, as well as any suggestions and comments for the improvement of the program. The opinions expressed in exit interview forms are reviewed by the DAC for implementation purposes.

vii. Alumni Survey

The survey asks former students of the department about the status of their employment and further education, perceptions of institutional emphasis, estimated gains in knowledge and skills, involvement as undergraduate students, and continuing involvement with Institute of Aeronautical Engineering. This survey is administered every three years. The data obtained will be analyzed and used in continuous improvement.

viii. Employer Survey

The main purpose of this employer questionnaire is to know employer's views about the skills they require of employees compared to the skills actually possessed by them. The purpose is also to identify gaps in technical and vocational skills, need for required training practices to fill these gaps and criteria for hiring new employees. These employer surveys are reviewed by the College Academic Council (CAC) to affect the present curriculum to suit the requirements of the employer.

ix. Laboratory and Project Works

The laboratory work is continuously monitored and assessed to suit the present demands of the industry. Students are advised and guided to do project works giving solutions to research/industrial problems to the extent possible by the capabilities and limitations of the student. The results of the assessment of the individual projects and laboratory work can easily be conflated in order to provide the students with periodic reviews of their overall progress and to produce terminal marks and grading.

x. Balanced Composition in Curriculum

The undergraduate program in electronics and communication engineering is designed to prepare students for successful careers in engineering and related fields by providing a balanced education, that prepares students to apply analytical, computational, experimental, and methodological tools to solve engineering problems; a strong foundation in mathematics and physical sciences; a broad and balanced general education in the humanities, arts, social sciences, and interdisciplinary studies; sufficient training and development of skills for effective communication and teamwork; a proper understanding of an engineer's professional and ethical responsibilities in relation to engineering fields and society; and recognition of the need for lifelong learning. The student's intellectual and ethical development is assessed continuously in relation to the

balanced composition in curriculum.

xi. Department Academic Committee and Faculty Meetings

The DAC meets bi-annually for every academic year to review the strategic planning and modification of PEOs. Faculty meetings are conducted at least once in fort night for ensuring the implementation of DAC's suggestions and guidelines. All these proceeding are recorded and kept for the availability of all faculties.

xii. Professional Societies

The importance of professional societies like IEEE, IETE, ISTE etc., are explained to the students and they are encouraged to become members of the above to carry out their continuous search for knowledge. Student and faculty chapters of the above societies are constituted for a better technical and entrepreneurial environment. These professional societies promote excellence in instruction, research, public service and practice.

Part - II

METHODOLOGY FOR PREPARATION AND ASSESSMENT OF COURSE LEVEL STUDENT LEARNING OUTCOMES

Although the term "Expected Learning Outcome" may be new, the process of identifying the key concepts or skills that students are expected to learn during specific courses is not. Many people are more familiar with the terms "course objective" or "course competency". Expected learning outcomes are really very similar to both of these concepts, so if you already have course objectives or competencies, you are close to having expected learning outcomes for class.

This will provide information on exactly what expected learning outcomes are and what methods can be used to assess them. This is designed to assist faculty with the process of developing expected learning outcomes and methods for assessing those outcomes in their courses. This provides basic information related to (1) course purpose; (2) expected learning outcomes; (3) methods for assessing expected learning outcomes; (4) criteria for grade determination; and (5) course outline.

Expected Learning Outcomes:

After reading and completing this, individuals will be able to:

- Prepare a description of the course as well as a written statement regarding the course's purpose;
- Construct/develop expected learning outcomes for the course;
- Create an assessment plan that outlines the specific methods that will be used to assess the expected student learning outcomes for a course;
- Describe how grades will be determined in a process that is separate and distinct from assessing the expected learning outcomes;
- Identify the common components of a course outline
- Revise their course syllabi to incorporate a course purpose, expected learning outcomes, methods to assess those outcomes, the criteria for grade determination, and a course outline.
- This process uses some terminology related to expected learning outcomes and assessment. A brief glossary of terms has been provided below for reference purposes.

Assessment of expected learning outcomes:
The process of investigating (1) what students are learning and (2) how well they are learning it in relation to the stated expected learning outcomes for the course.

Assessment plan:
The proposed methods and timeline for assessment-related activities in a given course (e.g., when are you going to check what/how well the students are learning and how are you going to do that?).

Classroom Assessment Technique (CAT):
Angelo and Cross (1993) developed a variety of techniques/activities than can be used to assess students' learning. These CATs are often done anonymously and are not graded. These activities check on the class' learning while students are still engaged in the learning process. An example of a CAT is a non-graded quiz given a few weeks before the first exam.

Course description:
A formal description of the material to be covered in the course.

Course purpose:
The course purpose describes the intent of the course and how it contributes to the programme. The course purpose goes beyond the course description.

Expected learning outcome:
A formal statement of what students are expected to learn in a course (synonyms for "expected learning outcome" include learning outcome, learning outcome statement, and student learning outcome).

Evaluation:
Making a judgment about the quality of student's learning/work and assigning marks based on that judgment. Evaluation activities (such as exams, papers, etc.) are often seen as formal ways to assess the expected learning outcomes for a course.

Methods for assessing student learning outcomes:
This term refers to any technique or activity that is used to identify what students are learning or how well they are learning. Formal methods for evaluating student learning outcomes include Continuous Assessment Tests, Mid Semester Test, Tutorials, End Semester Examination etc. The assessment methods are used to identify how the well students have acquired the learning outcomes for the course.

1. COURSE PURPOSE

One of the first steps in identifying the expected learning outcomes for a course is identifying the purpose of teaching in the course. By clarifying the purpose of the course, faculty can help discover the main topics or themes related to students' learning. These themes help to outline the expected learning outcomes for the course.

The course purpose involves the following:

1. What role does this course play within the programme?
2. How is the course unique or different from other courses?
3. Why should/do students take this course? What essential knowledge or skills should they gain from this experience?
4. What knowledge or skills from this course will students need to have mastered to perform well in future classes or jobs?
5. Why is this course important for students to take?

The "Course Description" provides general information regarding the topics and content addressed in the course, the "Course Purpose" goes beyond that to describe how this course fits in to the students' educational experience in the programme.

2. EXPECTED LEARNING OUTCOMES

Expected Learning Outcome (definition)
An expected learning outcome is a formal statement of what students are expected to learn in a course. Expected learning outcome statements refer to specific knowledge, practical skills, areas of professional development, attitudes, higher-order thinking skills, etc. that faculty members expect students to develop, learn, or master during a course (Suskie, 2004). Expected learning outcomes are also often referred to as "learning outcomes", "student learning outcomes", or "learning outcome statements".

Simply stated, expected learning outcome statements describe:
- What faculty members want students to know at the end of the course and
- What faculty members want students to be able to do at the end of the course

Learning outcomes have three major characteristics
- They specify an action by the students/learners that is **observable**
- They specify an action by the students/learners that is **measurable**
- They specify an action that is done by the **students/learners** (rather than the faculty members)

Effectively developed expected learning outcome statements should possess all three of these characteristics. When this is done, the expected learning outcomes for a course are designed so that they can be assessed (Suskie, 2004).

3. TO DEFINE EFFECTIVE LEARNING OUTCOME STATEMENTS

When stating expected learning outcomes, it is important to use verbs that describe exactly what the learner(s) will be able to do upon completion of the course.

Examples of good action words to include in expected learning outcome statements:
Compile, identify, create, plan, revise, analyze, design, select, utilize, apply, demonstrate, prepare, use, compute, discuss, explain, predict, assess, compare, rate, critique, outline, or evaluate

There are some verbs that are unclear in the context of an expected learning outcome statement (e.g., know, be aware of, appreciate, learn, understand, comprehend, and become familiar with). These words are often vague, have multiple interpretations, or are simply difficult to observe or measure (American Association of Law Libraries, 2005). As such, it is best to avoid using these terms when creating expected learning outcome statements.

For example, please look at the following learning outcomes statements:
- The students will understand basic Electronic components.
- The students will appreciate knowledge discovery from Communication techniques.

Both of these learning outcomes are stated in a manner that will make them difficult to assess. Consider the following:
- How do you observe someone "understanding" a theory or "appreciating" Data Mining techniques?
- How easy will it be to measure "understanding" or "appreciation"?

These expected learning outcomes are more effectively stated the following way:

- The students will be able to identify and describe what techniques are used to extract knowledge from Communication techniques.
- The students will be able to identify the characteristics of Classification techniques from other Digital Communication techniques.

Incorporating Critical Thinking Skills into Expected Learning Outcomes Statements

Many faculty members choose to incorporate words that reflect critical or higher-order thinking into their learning outcome statements. Bloom (1956) developed a taxonomy outlining the different types of thinking skills people use in the learning process. Bloom argued that people use different levels of thinking skills to process different types of information and situations. Some of these are basic cognitive skills (such as memorization) while others are complex skills (such as creating new ways to apply information). These skills are often referred to as critical thinking skills or higher-order thinking skills.

Bloom proposed the following taxonomy of thinking skills. All levels of Bloom's taxonomy of thinking skills can be incorporated into expected learning outcome statements. Recently, Anderson and Krathwohl (2001) adapted Bloom's model to include language that is oriented towards the language used in expected learning outcome statements. A summary of Anderson and Krathwohl's revised version of Bloom's taxonomy of critical thinking is provided below.

Definitions of the different levels of thinking skills in Bloom's taxonomy

1. **Remember** – recalling relevant terminology, specific facts, or different procedures related to information and/or course topics. At this level, a student can remember something, but may not really understand it.

2. **Understand** – the ability to grasp the meaning of information (facts, definitions, concepts, etc.) that has been presented.

3. **Apply** – being able to use previously learned information in different situations or in problem solving.

4. **Analyze** – the ability to break information down into its component parts. Analysis also refers to the process of examining information in order to make conclusions regarding cause and effect, interpreting motives, making inferences, or finding evidence to support statements/arguments.

5. **Evaluate** – being able to judge the value of information and/or sources of information based on personal values or opinions.

6. **Create** – the ability to creatively or uniquely apply prior knowledge and/or skills to produce new and original thoughts, ideas, processes, etc. At this level, students are involved in creating their own thoughts and ideas.

List of Action Words Related to Critical Thinking Skills

Here is a list of action words that can be used when creating the expected student learning outcomes related to critical thinking skills in a course. These terms are organized according to the different levels of higher-order thinking skills contained in Anderson and Krathwohl's(2001) revised version of Bloom's taxonomy.

REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
Choose	Classify	Apply	Analyze	Agree	Adapt
Define	Compare	Build	Assume	Appraise	Build
Find	Contrast	Choose	Categorize	Assess	Change
How	Demonstrate	Construct	Classify	Award	Choose
Label	Explain	Develop	Compare	Choose	Combine
List	Extend	Experiment with	Conclusion	Compare	Compile
Match	Illustrate	Identify	Contrast	Conclude	Compose
Name	Infer	Interview	Discover	Criteria	Construct
Omit	Interpret	Make use of	Dissect	Criticize	Create
Recall	Outline	Model	Distinguish	Decide	Delete
Relate	Relate	Organize	Divide	Deduct	Design
Select	Rephrase	Plan	Examine	Defend	Develop
Show	Show	Select	Function	Determine	Discuss
Spell	Summarize	Solve	Inference	Disprove	Elaborate
Tell	Translate	Utilize	Inspect	Estimate	Estimate
What			List	Evaluate	Formulate
When			Motive	Explain	Happen
Where			Relationships	Importance	Imagine
Which			Simplify	Influence	Improve
Who			Survey	Interpret	Invent
Why			Take part in	Judge	Make up
			Test for	Justify	Maximize
			Theme	Mark	Minimize
				Measure	Modify
				Opinion	Original
				Perceive	Originate
				Prioritize	Plan
				Prove	Predict
				Rate	Propose
				Recommend	Solution
				Rule on	Solve
				Select	Suppose
				Support	Test
				Value	Theory

4. TIPS FOR DEVELOPING COURSE LEVEL EXPECTED LEARNING OUTCOMES STATEMENTS

- Limit the course-level expected learning outcomes to 5 - 10 statements for the entire course (more detailed outcomes can be developed for individual units, assignments, chapters, etc.).
- Focus on overarching or general knowledge and/or skills (rather than small or trivial details).
- Focus on knowledge and skills that are central to the course topic and/or discipline.
- Create statements that are student-centered rather than faculty-centered (e.g., "upon completion of this course students will be able to list the name of all Communication techniques" versus "one objective of this course is to teach the names of all Communication techniques").
- Focus on the learning that results from the course rather than describing activities or lessons in the course.
- Incorporate or reflect the institutional and departmental missions.

Incorporate various ways for students to show success (outlining, describing, modeling, depicting, etc.) rather than using a single statement such as "at the end of the course, students will know _____" as the stem for each expected outcome statement.

5. SAMPLE EXPECTED LEARNING OUTCOMES STATEMENTS

The following depict some sample expected learning outcome statements from selected courses.

Electronic Devices and circuits:

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

- Get clear understanding of internal physical behavior of PN junction Diode.
- Understand the breakdown mechanisms in semiconductors so as to construct a Zener voltage regulator used in regulated power supplies.
- Analyze various rectifiers and filter circuits used in regulated power supplies.
- Understand and operate the special purpose electronic devices (Tunnel Diode, Varactor Diode, LED, LCD & Photo diode), for various applications like digital display boards, fiber optic links, remote control equipment and etc.
- Understand the construction, operation and characteristics of Bipolar Junction Transistor, which can be used in the design of amplifiers.
- Understand the construction, operation and characteristics of JFET and MOSFET, which can be used in the design of amplifiers.
- Understand the need and requirements of biasing a transistor so that to avoid the failure of electronic circuits due to thermal effects
- Use this course as prerequisite to understand the more advanced courses like ECA, PDC, ICA, VLSI and etc.

Signals and Systems:

Students who complete this course should be able to:

- Understand the principles of vector spaces, including how to relate the concepts of basis, dimension, inner product, and norm to signals. Know how to analyze, design, approximate, and manipulate signals using vector-space concepts.
- Understand and classify signals (e.g. periodic, even) and systems (e.g. causal, linear) and an understanding of the difference between discrete and continuous time signals and systems, understand the principles of impulse functions, step function and signum function.
- Analyze the implications of linearity, time-invariance, causality, memory, and bounded-input, bounded-out (BIBO) stability.
- Determine the response of linear systems to any input signal by convolution in the time domain, and by transformation to the frequency domain, filter characteristics of a system and its bandwidth, the concepts of auto correlation and cross correlation and power density spectrum.
- Understand the definitions and basic properties (e.g. time-shift, modulation, Parseval's Theorem) of Fourier series, Fourier transforms, Laplace transforms, Z transforms, and an ability to compute the transforms and inverse transforms of basic examples using methods such as partial fraction expansions, ROC of Z Transform/ Laplace Transform.

- Analyze the Sampling theorem, reconstruction, aliasing, and Nyquist's theorem to represent continuous-time signals in discrete time so that they can be processed by digital computers.

6. AN OVERVIEW OF ASSESSMENT

What is assessment?
According to Palomba and Banta (1999) assessment involves the systematic collection, review, and use of evidence or information related to student learning. Assessment helps faculty understand how well their students understand course topics/lessons. Assessment exercises are often anonymous. This anonymity allows students to respond freely, rather than trying to get the "right" answer or look good. Assessment exercises attempt to gauge students' understanding in order to see what areas need to be re-addressed in order to increase the students' learning.

In other words, assessment is the process of investigating (1) what students are learning and (2) how well they are learning it in relation to the stated expected learning outcomes for the course. This process also involves providing feedback to the students about their learning and providing new learning opportunities/strategies to increase student learning.

For example, Dr. JVR initiates a class discussion on material from Chapter One and determines that most students are confused about Topic X. This class discussion served as a method for assessing student learning and helped determine the fact that student learning related to Topic X is somewhat lacking. Dr. JVR now has the opportunity to (1) inform the students that there is some confusion and (2) make adjustments to address this confusion (e.g., ask student to re-read Chapter One, re-lecture over Topic X, etc.). This assessment process helps increase students' learning.

What is the difference between "evaluation" and "assessment"?
Evaluation focuses on making a judgment about student work to be used in assigning marks that express the level of student performance. Evaluation is usually used in the process of determining marks. Evaluation typically occurs after student learning is assumed to have taken place (e.g., a final exam). Evaluation is part of the assessment process. Course assignments that are evaluated/graded (e.g., exams, papers, tutorials, etc.) are often seen as formal assessment techniques.

While evaluation is an important component of most classrooms, it does have some limitations. For example, if the class average on an exam is a 45%, is seems pretty clear that something went wrong along the way. When one has only evaluated the final learning product, it can be challenging to go back and discover what happened. It can also be difficult to address the situation or provide opportunities for students to learn from their mistakes. Yes, a curve on an exam can help address a low class average, but does it help the students learn? Engaging in informal assessment activities throughout the course can help avoid this situation.

What is involved in the assessment process?

1. Establishing expected learning outcomes for the course;
2. Systematically gathering, analyzing, and interpreting evidence (through formal assessment activities such as exams or papers and informal assessment activities such as in-class discussions exercises) to determine how well the students' learning matches:
    - Faculty expectations for what students will learn and
    - The stated expected learning outcomes for the course
3. Faculty members should use this evidence/assessment of student learning to:
    - Provide questionery to students about their learning (or lack thereof) and

- Adjust their teaching methods and/or students' learning behaviors to ensure greater student learning (Maki, 2004).

The Best Practice in a Classroom Assessment and is an example of a method that can be used to assess learning outcomes. At the end of a class period or major topic, faculty ask students to anonymously write down what point(s) were the most unclear to them. After class, faculty members review these responses and then re-teach or re-address any confusing topics, thus increasing student learning (Angelo & Cross, 1993).

7. DESCRIPTION OF A COURSE PURPOSE

When planning a course and determining the Learning Outcomes for that course, it is important to examine the course's purpose within the context of the college, and/or the department/program. This process will assist faculty in determining the intent of the course as well as how the course fits into the curriculum. This will help identify the essential knowledge, skills, etc. that should be incorporated into the course and the stated expected learning outcomes for the course. The course purpose section should clarify the level of the course within the programme (e.g., is the course required as a core or an elective and whether it requires any pre-requisites etc.). It should also describe the course's role in the departmental/programmatic curriculum by addressing the intent (importance, main contribution etc.) of the course.

STEP ONE: Determine if the course is part of the IEEE / ACM / AICTE Model Curriculum
The earliest curriculum was published in 1968 for computer science (CS) by the Association for Computing Machinery (ACM), and in 1977 the Computer Society of the Institute for Electrical and Electronic Engineers (IEEE-CS) provided its first curriculum recommendations. In the late 1980's the ACM and the IEEE-CS together formed a task force to create curricula for computer science and computer engineering. The core curriculum covers classes in computer science curriculum, and subsequently separate curricula reports were issued for information systems, software engineering and computer engineering

STEP TWO: Determine how the course fits into the departmental curriculum
Here are some questions to ask to help determine how a course fits in the departmental curriculum:
What role does the course play in the departmental/programmatic curriculum?

- Is this course required?
- Is this course an elective?
- Is this course required for some students and an elective for others?
- Does this class have a pre-requisite?
- Is this class a pre-requisite for another class in the department?
- Is this course part of IEEE / AICTE Model Curriculum?

How advanced is this course?

- Is this course an undergraduate or graduate course?
- Where does this course fall in students' degree plan - as an introductory course or an advanced course?
- Can I expect the students taking this course to know anything about the course topic?
- Are other faculty members counting on students who have taken this course to have mastered certain knowledge or skills?

When students leave this course, what do they need to know or be able to do?

- Is there specific knowledge that the students will need to know in the future?
- Are there certain practical or professional skills that students will need to apply in the future?
- Five years from now, what do you hope students will remember from this course?

What is it about this course that makes it unique or special?

- Why does the program or department offer this course?
- Why can't this course be "covered" as a sub-section of another course?
- What unique contributions to students' learning experience does this course make?
- What is the value of taking this course? How exactly does it enrich the program or department?

8. PROCEDURE FOR DEVELOPMENT OF EXPECTED LEARNING OUTCOMES FOR A COURSE

The following pages should be of assistance in developing several broad, effectively stated expected learning outcomes for a course. When beginning to construct expected learning outcome statements, it is always good to think about the learners.
Please take a moment to think about the student learners in the course. Please consider the following questions:

- What are the most essential things the students need to know or be able to do at the end of this course?
- What knowledge and skills will they bring with them?
- What knowledge and skills should they learn from the course?

When you begin thinking about the expected learning outcomes for a course, it is a good idea to think broadly. Course-level expected learning outcomes do not need to focus on small details; rather, they address entire classes of theories, skill sets, topics, etc.

The "Course Description" contains the following contents:

- Course Overview
- Prerequisite(s)
- Marks Distribution
- Evaluation Scheme
- Course Objectives
- Course Outcomes
- How Course Outcomes are assessed
- Syllabus
- List of Text Books / References / Websites / Journals / Others
- Course Plan
- Mapping course objectives leading to the achievement of the program outcomes
- Mapping course outcomes leading to the achievement of the program outcomes

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ANNEXURE - A: SAMPLE COURSE DESCRIPTION (As Per NBA Norms post June, 2015**)**

INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**SIGNALS AND SYSTEMS**			
Course Code	**A30406**			
Regulation	**R13 – JNTUH**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	4	1	-	4
Course Coordinator	Mrs. L Shruthi, Assistant Professor, ECE			
Team of Instructors	Mr. N Nagaraju, Assistant Professor, ECE			

I. COURSE OVERVIEW:

Signals and Systems encounter extensively in our day-to-day lives, from making a phone call, listening to a song, editing photos, manipulating audio files, using speech recognition software's like Siri and Google now, to taking EEGs, ECGs and X-Ray images. Each of these involves gathering, storing, transmitting and processing information from the physical world. This course will equip to deal with these tasks efficiently by learning the basic mathematical framework of signals and systems. Here we will explore the various properties of signals and systems, characterization of Linear Time Invariant Systems/ Time variant systems, convolution and Fourier Series and Transform, and also deal with the Sampling theorem, Z-Transform, Correlation and Laplace transform. Ideas introduced in this course will be useful in understanding further Electronic/Electrical Engineering courses which deal with control systems, communication systems, digital signal processing, statistical signal analysis and digital message transmission. Further concepts such as signal sampling and aliasing are introduced. The theory is exemplified with processing of signals in MATLAB.

II. PREREQUISITE(S):

Level	Credits	Periods/ Week	Prerequisites
UG	4	5	Engineering Mathematics, Basics of Vector Theory

III. MARKS DISTRIBUTION:

Sessional Marks	University End Exam Marks	Total Marks
Midterm Test There shall be two midterm examinations. Each midterm examination consists of essay paper, objective paper and assignment. The essay paper is for 10 marks of 60 minutes duration and shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks. The objective paper is for 10 marks of 20 minutes duration. It consists of 10	75	100

Sessional Marks	University End Exam Marks	Total Marks
multiple choice and 10 fill-in-the blank questions, the student has to answer all the questions and each carries half mark. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Assignments are usually issued at the time of commencement of the semester. These are of problem solving in nature with critical thinking. Marks shall be awarded considering the average of two midterm tests in each course.		

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1.	I Mid Examination	80 minutes	20
2.	I Assignment	-	5
3.	II Mid Examination	80 minutes	20
4.	II Assignment	-	5
5.	External Examination	3 hours	75

V. COURSE OBJECTIVES:

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

I. To provide background and fundamentals vectors for the analysis and processing of signals.
II. Evaluate the Fourier series of periodic signals and its properties.
III. Determine the Fourier Transform of signals and its properties.
IV. Convert a continuous time signal to the discrete time domain and reconstruct using the sampling theorem.
V. Analyze a discrete time LTI/LT systems using linear convolution.
VI. Apply the convolution theorem and correlation for continuous time signals.
VII. Use Laplace and Z-transform for analyzing Continuous/ Discrete time signals and systems.

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. **Understand** the principles of vector spaces, including how to relate the concepts of basis, dimension, inner product, and norm to signals. Know how to analyze, design, approximate, and manipulate signals using vector-space concepts.
2. **Understand** and classify signals (e.g. periodic, even) and systems (e.g. causal, linear) and an understanding of the difference between discrete and continuous time signals and systems, understand the principles of impulse functions, step function and signum function.
3. **Analyze** the implications of linearity, time-invariance, causality, memory, and bounded-input, bounded-out (BIBO) stability.

4. **Determine** the response of linear systems to any input signal by convolution in the time domain, and by transformation to the frequency domain, filter characteristics of a system and its bandwidth, the concepts of auto correlation and cross correlation and power density spectrum.
5. **Understand** the definitions and basic properties (e.g. time-shift, modulation, Parseval's Theorem) of Fourier series, Fourier transforms, Laplace transforms, Z transforms, and an ability to compute the transforms and inverse transforms of basic examples using methods such as partial fraction expansions, ROC of Z Transform/ Laplace Transform.
6. **Analyze** the Sampling theorem, reconstruction, aliasing, and Nyquist's theorem to represent continuous-time signals in discrete time so that they can be processed by digital computers.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	**Engineering Knowledge** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	H	Assignments, Tutorials
PO2	**Problem Analysis** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	S	Assignments
PO3	**Design/Development of Solutions** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	H	Mini Projects
PO4	**Conduct Investigations of Complex Problems** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions	H	Projects
PO5	**Modern Tool Usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations	S	Projects
PO6	**The Engineer and Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice	N	--
PO7	**Environment and Sustainability** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development	N	--
PO8	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice	S	Oral Discussions
PO9	**Individual and Team Work** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings	N	--
PO10	**Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	S	Presentations
PO11	**Life-long Learning** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the	S	Seminars, Discussions

Program Outcomes		Level	Proficiency assessed by
	broadest context of technological change		
PO12	**Project Management and Finance** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments	H	Development of Prototype, Projects

N - None **S - Supportive** **H - Highly Related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.	H	Lectures, Assignments
PSO2	**Problem-solving skills:** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.	S	Tutorials
PSO3	**Successful career and Entrepreneurship:** An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.	S	Seminars and Projects

N - None **S - Supportive** **H - Highly Related**

IX. SYLLABUS:

UNIT -I:

Signal Analysis and Fourier series

Signal Analysis: Analogy between Vectors and Signals, Orthogonal Signal Space, Signal approximation using Orthogonal functions, Mean Square Error, Closed or complete set of Orthogonal functions, Orthogonality in Complex functions, Exponential and Sinusoidal signals, Concepts of Impulse function, Unit Step function, Signum function.

Fourier Series: Representation of Fourier series, Continuous time periodic signals, Properties of Fourier Series, Dirichlet's conditions, Trigonometric Fourier Series and Exponential Fourier Series, Complex Fourier spectrum.

UNIT-II:

Fourier Transforms and Sampling

Fourier Transforms: Deriving Fourier Transform from Fourier Series, Fourier Transform of arbitrary signal, Fourier Transform of standard signals, Fourier Transform of Periodic Signals, Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function, Introduction to Hilbert Transform.

Sampling: Sampling theorem – Graphical and analytical proof for Band Limited Signals, Types of Sampling Impulse Sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, Effect of under sampling – Aliasing, Introduction to Band Pass sampling.

UNIT-III:

Signal Transmission Through Linear Systems: Linear System, Impulse response, Response of a Linear System, Linear Time Invariant (LTI) System, Linear Time Variant (LTV) System, Transfer function of a LTI system, Filter characteristics of Linear Systems, Distortion less transmission through a system, Signal bandwidth, System bandwidth, Ideal LPF, HPF and BPF characteristics, Causality and Paley-Wiener criterion for physical realization, Relationship between Bandwidth and Rise time.

UNIT-IV:

Convolution and Correlation of Signals: Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution, Convolution property of Fourier Transforms, Cross Correlation and Auto Correlation of functions, Properties of Correlation function, Energy density spectrum, Parseval's Theorem, Power density spectrum, Relation between Auto Correlation function and Energy/Power spectral density function, Relation between Convolution and Correlation, Detection of periodic signals in the presence of Noise by Correlation, Extraction of signal from noise by filtering.

UNIT-V:

Laplace Transforms and Z-Transforms

Laplace Transforms: Review of Laplace Transforms (L.T), Partial fraction expansion, Inverse Laplace Transform, Concept of Region of Convergence (ROC) for Laplace Transforms, Constraints on ROC for various classes of signals, Properties of L.T, Relation between L.T and F.T of a signal, Laplace Transform of certain signals using waveform synthesis.

Z–Transforms: Fundamental difference between Continuous and Discrete time signals, Discrete time signal representation using Complex exponential and Sinusoidal components, Periodicity of Discrete time signal using complex exponential signal, Concept of Z- Transform of a Discrete Sequence, Distinction between Laplace, Fourier and Z Transforms, Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Inverse Z-transform, Properties of Z-transforms.

TEXT BOOKS:

1. Signals, Systems & Communications - B.P. Lathi, 2013, BSP. (T1)
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, 2 Ed., PHI. (T2)

REFERENCE BOOKS:

1. Signals & Systems - Simon Haykin and Van Veen,Wiley, 2 Ed. (R1)
2. Signals and Signals – Iyer and K. Satya Prasad, Cengage Learning. (R2)
3. Signals and Systems – A.Rama Krishna Rao – 2008, TMH. (R3)
4. Introduction to Signal and System Analysis – K.Gopalan 2009, Cengage Learning. (R4)
5. Fundamentals of Signals and Systems - Michel J. Robert, 2008, MGH International Edition. (R5)
6. Signals, Systems and Transforms - C. L. Philips, J.M.Parr and Eve A.Riskin, 3 Ed., 2004, PE. (R6)

IX. COURSE PLAN:

At the end of the course, the students are able to achieve the following course learning outcomes:

Lecture No.	Unit No	Course Learning Outcome	Topics Covered	Text Book/ Reference
1-4	I	**Discuss** the analogy between vectors and signals. **Describe** the signal approximation using orthogonal functions	Analogy between vectors and signals, Orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, Closed or complete set of orthogonal functions	T1-3.1, 3.2
5-8		**Discuss** about Exponential and sinusoidal signals, Concepts of Impulse	Orthogonality in complex functions Exponential and sinusoidal signals, Concepts of Impulse function, Unit step	T1-3.2

Lecture No.	Unit No	Course Learning Outcome	Topics Covered	Text Book/ Reference
		function, Unit step function, Signum function.	function, Signum function.	
9-12		**Illustrate** Fourier series, Continuous time periodic signals, properties of Fourier series	Representation of Fourier series, Continuous time periodic signals, properties of Fourier series,	T1-3.3
13-17		**Illustrate** Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Complex Fourier spectrum	Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Complex Fourier spectrum	T1-3.3,3.4,3.5,3.6
18-20	II	**Compute** Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals	Deriving Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals	T1-4.1,4.5,4.6,4.7
21-24		**Illustrate** the Properties of Fourier transforms, Fourier transforms involving impulse function and Signum function and Introduction to Hilbert Transform.	Properties of Fourier transforms, Fourier transforms involving impulse function and Signum function, Introduction to Hilbert Transform.	T1-4.8,6.5,
25-28		**Illustrate** Sampling theorem and , Types of sampling	Sampling theorem – Graphical and analytical proof for Band Limited Signals, Types of sampling-impulse sampling, Natural and Flat top Sampling	R1-3.5
29-31		**Illustrate** Reconstruction of signal from its samples, effect of under sampling	Reconstruction of signal from its samples, effect of under sampling – Aliasing, Introduction to Band Pass sampling.	R1-3.6
32-33	III	**Demonstration** of Linear system, impulse response, Response of a linear system, Linear time invariant (LTI) system, Linear time variant (LTV) system. **compute** Transfer function of a LTI system.	Linear system, impulse response, Response of a linear system, Linear time invariant (LTI) system, Linear time variant (LTV) system, Transfer function of a LTI system.	T1-6.1,6.8,
34-35		**Discuss** Filter characteristics of linear systems, . Distortion less transmission through a system, Signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics,	Filter characteristics of linear systems. Distortion less transmission through a system, Signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics,	T1-6.11,6.1,6.14
36-37		**Demonstrate** the Causality and Paley-Wiener criterion for physical realization,, **Analyze** Relationship between bandwidth and rise time	Causality and Paley-Wiener criterion for physical realization, Relationship between bandwidth and rise time.	T1-6.15

Lecture No.	Unit No	Course Learning Outcome	Topics Covered	Text Book/ Reference
38-40	IV	**Express** concept of convolution in time domain and frequency domain, Graphical representation of convolution **Explain** Convolution property of Fourier transforms	Concept of convolution in time domain and frequency domain, Graphical representation of convolution, Convolution property of Fourier transforms.	T1-11.1, 11.2, 11.3
41-45		**Demonstrate** cross correlation and auto correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum	Cross correlation and auto correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum	T1-12.2,12.3, 4.9
46-48		**Discuss** relation between autocorrelation function and energy/power spectral density function **Express** Relation between convolution and correlation	Relation between autocorrelation function and energy/power spectral density function, Relation between convolution and correlation	T1-12.1,12.2
49-51		**Discuss** the detection of periodic signals in the presence of noise by correlation, Extraction of signal from noise by filtering.	Detection of periodic signals in the presence of noise by correlation, Extraction of signal from noise by filtering.	T1-12.5,12.7
52-55	V	**Describe** Laplace transforms, Partial fraction expansion, Inverse Laplace transform, Concept of region of convergence (ROC) for Laplace transforms.	Review of Laplace transforms, Partial fraction expansion, Inverse Laplace transform, Concept of region of convergence (ROC) for Laplace transforms.	R1-6.1,6.2,6.3 ,6.5,6.9
56-59		**Examine** the constraints on ROC for various classes of signals **Describe** Properties of L.T's relation between L.T's, and F.T. of a signal. Laplace transform of certain signals using waveform synthesis.	Constraints on ROC for various classes of signals, Properties of L.T's relation between L.T's, and F.T. of a signal. Laplace transform of certain signals using waveform synthesis.	T1-6.4,6.8
60-61		**Examine** the fundamental difference between continuous and discrete time signals **Analyze** discrete time signal representation using complex exponential and sinusoidal components, Periodicity of discrete time using complex exponential signal	Fundamental difference between continuous and discrete time signals, discrete time signal representation using complex exponential and sinusoidal components, Periodicity of discrete time using complex exponential signal	R1-7.1
62-64		**Describe** concept of Z-	Concept of Z- Transform of a discrete	R1-

Lecture No.	Unit No	Course Learning Outcome	Topics Covered	Text Book/ Reference
		Transform of a discrete sequence, Distinction between Laplace, Fourier and Z transforms, Region of convergence in Z-Transform, constraints on ROC for various classes of signals	sequence, Distinction between Laplace, Fourier and Z transforms, Region of convergence in Z-Transform, constraints on ROC for various classes of signals	7.2,7.3,7.4 ,7.5

X. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H							S				H		S	S
II		S								S			H	S	
III				H				S			S		H	S	
IV			H		S							H	H	S	
V	H			H										S	
VI		S			S					S			H	S	
VII				H							S	H	H	S	S

S – Supportive **H - Highly Related**

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H		H					S			S	H		S	S
2	H				S						S		H	S	
3		S			S			S				H	H	S	
4	H			H				S		S	S			S	
5	H	S	H		S								H	S	
6	H		H	H						S			H	S	

S – Supportive **H - Highly Related**

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