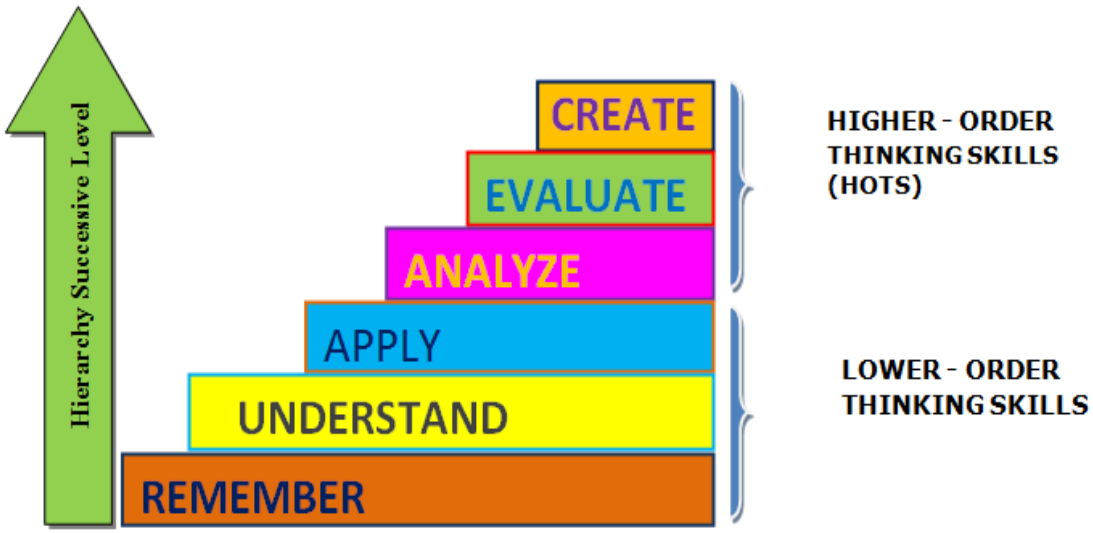
OUTCOME BASED EDUCATION BOOKLET

B.Tech

ELECTRICAL AND ELECTRONICS ENGINEERING

(Accredited by NBA)

2016–2017 & 2017-2018



BLOOM'S TAXONOMY OF LEARNING OUTCOMES

.....Moving Towards Perfection in Engineering

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Approved by AICTE; Affiliated to JNTUH and Accredited by NAAC with 'A' Grade
Dundigal, Hyderabad - 500 043

VISION & MISSION

VISION

To produce comprehensively trained, socially responsible, innovative electrical engineers and researchers of high quality who can contribute for the nations and global development.

MISSION

The mission of Electrical and Electronics Engineering is to provide academic environment with a strong theoretical foundation, practical engineering skills, experience in interpersonal communication and teamwork along with emphasis on ethics, professional conduct and critical thinking. Further, the graduates will be trained to have successful engagement in research and development and entrepreneurship.

Contents
Program Education Objectives and Outcomes

As Per NBA Norms Post June, 2015

Semester: I-I, I-II,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 BOS EEE on 24/1/2015):

Electrical and Electronics Engineering Board Of Studies (EEEBOS):

The Electrical and Electronics Engineering Board Of Studies (EEEBOS) is composed from a diverse group of representatives from academe, industry and importantly the alumni. The "Program Educational Objectives**"** were initially drafted by a committee of EEE faculty and were vetted and approved by a group of faculty from peer department, Electrical And Electronics Engineering. Assessment data for evaluation of effectiveness of the program and achievement of program objectives is collected annually through "alumni surveys" and every three years through "employer surveys". This information is compiled by departmental committee and presented to EEE department.

External Advisory Board for review. The feedback and recommendation of EEE Board are implemented for improvements year on year. The meeting of Board members is conducted annually. Additional meetings are conducted as required, to review strategic planning and innovative programs for their impact on programs. The Board members visits the institute and holds meeting with representatives of administration, faculty and the students. The secretary of departmental Board presents a report to the council, on improvements and amendments to the program. The Board Of Studies prepares a status report for action and review by the Principal.

B. Tech - Electrical and Electronics Engineering Program

The Electrical and Electronics Engineering department at the institute is dedicated to providing educational opportunities in Electrical and Electronics Engineering to specific undergraduate student body of talented girls and boys. The department emphasizes close interactions between students and the faculty dedicated to education and actively engaged in events enriching the educational programs. The program emphasizes active learning with a strong laboratory component. The department nurtures the intellectual, professional, and personal development of students with a view to transform them to competent professionals and responsible members of the society.

1. PROGRAM EDUCATIONAL OBJECTIVES, OUTCOMES AND ASSESSMENT CRITERIA

Learning Outcomes, Assessment Criteria:

The **educational objectives** of a module are statements of the broad intentions of the teaching team. They indicate what the teaching team intends to cover and the learning opportunities they intend to make available to student. A **learning outcome** is a statement of what a learner (student) is expected to know, understand and /or be able to do at the end of learning period. The department prefers to express learning outcomes with following common prefix:

'On completion of course (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. A balance is struck between the degree of specificity in a learning outcome statement and that achieved by the assessment criteria, below. On one hand too many learning outcomes, for a module, are considered akin to assessment criteria or curricular detail (EEE intend to describe the curriculum in a range statement) while too few learning outcomes fail to provide sufficient information on the course. As a practice between 3 and 6 learning outcomes are considered by the department for a course.

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

2. B. TECH - ELECTRICAL AND ELECTRONICS ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES

Program Educational Objective - I

To provide students with the knowledge of Basic Sciences in general and Electrical and electronics Engineering in particular so as to acquire the necessary skills for analysis and synthesis of problems in generation, transmission and distribution.

Program Educational Objective - II

To provide technical knowledge and skills to identify, comprehend and solve complex tasks in industry and research and inspire the students to become future researchers / scientists with innovative ideas.

Program Educational Objective - III

To prepare the students for successful employment in various Industrial and Government organizations, both at the National and International level, with professional competence and ethical administrative acumen so as to handle critical situations and meet deadlines.

Program Educational Objective - IV

To train the students in basic human and technical communication skills so that they may be good team-members, leaders and responsible citizen With a view to challenge ourselves and to nurture diverse capabilities for professional and intellectual growth for our graduates it is important for the department to define departmental objectives in generalized and broad format. Adherence to these objectives is proposed to be demonstrated through actions or achievements.

I. Following indicators are considered as demonstration of (success in Electrical and Electronics Engineering areas / other allied and diverse fields):

a. Acceptance and satisfactory progress by students in a graduate degree program.
b. Significantly contributing and delivery of desired engineering component, product or process.
c. Formulating and solving, moderately complex electrical and electronics engineering problems.
d. Skillful use of state-of-the-art tools for electrical and electronics engineering processes.
e. Making practical recommendations that address issues related to Electrical and Electronics Engineering product and systems.

f. Producing clear written electrical and electronics engineering documentation (papers, reports, and significant parts of proposals).

g. Being assigned to make reports or presentations for internal or external clients.

h. Publishing and reviewing papers for conferences / journals, or producing an internally reviewed publication.

i. Making a significant contribution to a proposal.

j. Making a useful invention and drafting/ applying for a patent.

k. Participating in the field through; public speaking, activity in professional societies/ technical associations etc.

l. Addressing issues related to intellectual property rights.

m. Capability to handle societal, ethical, legal, business and technical issues related to a project.

II. Contribute and excel in their fields or professions, develop professional ethics and leadership qualities may be demonstrated by any of the following:

a. Leading a project or designed team.

b. Promotion to managerial position.

c. Election or appointment to leadership position in a professional society.

d. Participating in one of the organization's NSS programs.

e. Volunteering in a college, civic or other charitable organization.

f. Participating in team sports or coaching.

g. Effectively handling a situation involving ethics

III. Professional attitude, effective communication skills, capabilities to succeed in multi-disciplinary or diverse fields may be demonstrated by any of the following:

a. Appropriately using tools for collaboration, such as telecoms, Videocon's etc.

b. Skillfully using tools for project and configuration management, like resource planning systems, software source control systems, etc.

c. Working successfully on ethnically, technically and gender diverse teams.

d. Effectively resolving problems encountered in team work.

e. Communicating effectively in a group environment.

f. Estimating correctly the required resources (time, team, equipment etc.) for Electrical and Electronics Engineering projects.

g. Making appropriate decisions on outsourcing and developing components in-house.

h. Seeking assistance or elevating problems when necessary.

IV. Continue to pursue professional development including continuing or advanced education relevant to their career growth and to create enthusiasm for sustained life-long learning may be demonstrated by any of the following:

a. Successfully completing the graduate course.

b. Self-learning; a new skill, tool, area system.

c. Reading technical books, journals, conference papers, technical reports or standards.

d. Attending a technical conference, symposium or workshop.

e. Belonging to a professional society.

The department of Electrical and Electronics 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, teaching assistants, those who hire or admit our graduates to other programs, members of related professional organizations, and colleagues from other educational institutions.

3. B. TECH – ELECTRICAL AND ELECTRONICS ENGINEERNIG PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

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

GENERAL PROGRAM OUTCOMES (POs)

PO - 1: **Engineering Knowledge**:

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

PO - 2: **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.

PO - 3: **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

PO - 4: **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.

PO - 5: **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.

PO - 6: **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

PO - 7: **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.

PO - 8: **Ethics**:

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

PO - 9: **Individual and Team Work**:

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

PO - 10: **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.

PO - 11: **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.

PO - 12:**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

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO - 1:

Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based teamwork.

PSO - 2:

Can explore the scientific theories, ideas, methodologies and the new cutting edge Technologies in renewable energy engineering, and use this erudition in their professional envelopment and gain sufficient competence to solve the current and future energy problems universally.

PSO - 3:

The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.

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

PEO-I	PEO-II	PEO-III	PEO-IV
PO: 1, 2, 3, 4, 5, 6, 7, 11, 12	**PO**: 1, 2, 3, 4, 5, 6, 8, 9, 10, 11	**PO**: 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12	**PO**: 6, 7, 8, 9, 10, 11, 12

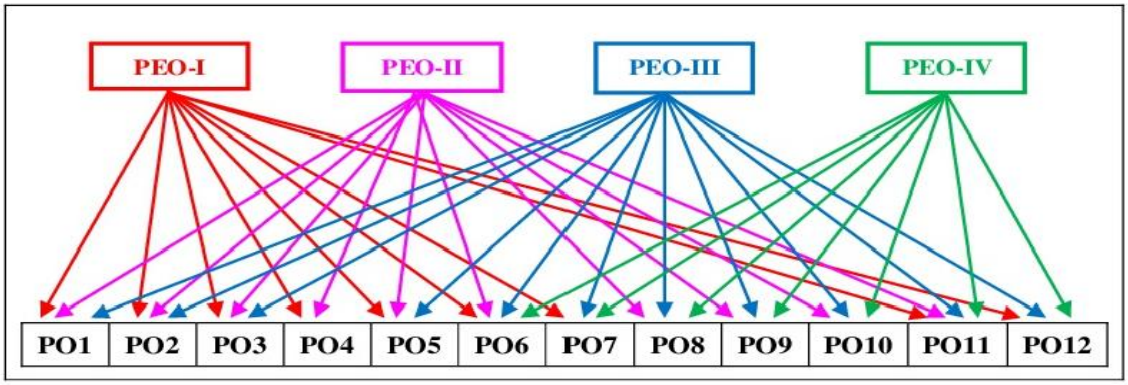


Figure: Correlation between the PEOs and the POs

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

PEO-I	PEO-II	PEO-III	PEO-IV
PSO: 1, 2	**PSO**: 1,3	**PSO**: 1,2,3	**PSO**: 2,3

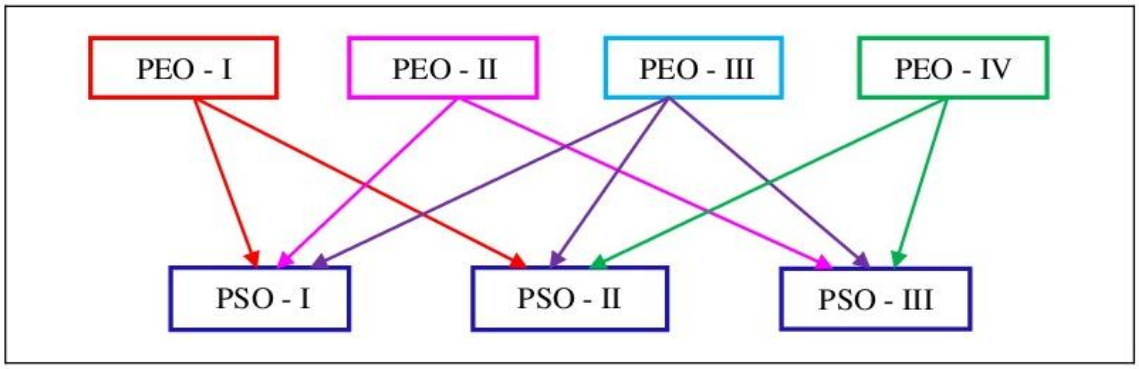


Figure: The correlation between the PEOs and the PSOs

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

S. No	Program Educational Objectives	Program Outcomes
I	Success in Electrical Engineering area	**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. **PO - 6**: **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 **PO - 7**: **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. **PO - 11**: **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. **PO - 12**:**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
II	**Industrial awareness and research**	**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. **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.
III	**Successful employment and professional ethics**	**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. **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.

IV	**Being an leader professional and societal environment**	**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.

S. No	Program Educational Objectives	PSO'S
I	**Success in Electrical Engineering area**	**PSO-1**: Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work. **PSO - 2**: Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional envelopment and gain sufficient competence to solve the current and future energy problems universally.
II	**Industrial awareness and research**	**PSO-1**: Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work. **PSO-3**:The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications
III	**Successful employment and**	**PSO-1**: Able to utilize the knowledge of high voltage engineering

	professional ethics	in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work. **PSO- 2**: Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional envelopment and gain sufficient competence to solve the current and future energy problems universally. **PSO-3**:The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.
IV	**Being an leader professional and societal environment**	**PSO-2**: Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional envelopment and gain sufficient competence to solve the current and future energy problems universally. **PSO-3**:The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.

5. RELATION BETWEEN THE PROGRAM EDUCATIONAL OBJECTIVES AND THE PROGRAM OUTCOMES, PROGRAM SPECIFIC OUTCOMES:

Broad relationship between the program objectives and the program outcomes is given in the Following Table Below:

Program Educational Objectives (PEOs) **Program Outcomes (POs)**		**I**	**II**	**III**	**IV**
		Success in Electrical Engineering Fields	**Industrial awareness and research**	**Successful employment and professional ethics**	**Being an leader professionally and societal environment**
PO-1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**3**	**3**	**3**	**2**
PO-2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**3**	**3**	**2**	**2**
PO-3	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.	**3**	**3**	**2**	**2**
PO-4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and	**3**	**3**	**2**	**2**

	synthesis of the information to provide valid conclusions.				
PO-5	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.	**3**	**3**	**2**	**2**
PO-6	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.	**2**	**3**	**3**	**3**
PO-7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	**2**	**2**	**3**	**3**
PO-8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**2**	**2**	**3**	**3**
PO-9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings	**2**	**3**	**3**	**3**
PO-10	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.	**2**	**3**	**3**	**3**
PO-11	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.	**2**	**3**	**3**	**3**
PO-12	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.	**2**	**2**	**3**	**3**
Relationship between Program Outcomes and Program Educational Objectives **Key: 3 = Highly Related; 2 = Medium; 1= Low**					

RELATION BETWEEN THE PROGRAM SPECIFIC OUTCOMES AND THE PROGRAM EDUCATIONAL OBJECTIVES

Program Educational Objectives (PEOs) Program Specific Outcomes (PSOs)		I	II	III	IV
		Success in Electrical Engineering Fields	Industrial awareness and research	Successful employment and professional ethics	Being an leader professionally and societal environment
PSO-1	Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	2	3	3	2
PSO-2	Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional envelopment and gain sufficient competence to solve the current and future energy problems universally.	3	2	3	2
PSO-3	The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications	2	2	2	3
Relationship between Program Specific Outcomes and Program Educational Objectives Key: 3 = Highly Related; 2 = Medium; 1= Low					

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 OUTCOMESOF (B. Tech) EEE GRADUATES

Graduates from accredited program 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

PO–1; Engineering knowledge: **Apply the knowledge of mathematics, science, engineering Fundamentals and an engineering specialization to the solution of complex engineering Problems.**

Performance Criteria Definitions:

- Knowledge and understanding of scientific principles and methodology necessary to strengthen their education in their engineering discipline, to enable appreciation of its scientific and engineering context and to support their understanding of historical, current and future developments and technologies
- Knowledge and understanding of mathematical principles necessary to underpin their education in their engineering discipline and to enable them to apply mathematical problems
- Ability to apply and integrate knowledge and understanding of other engineering disciplines to support the study of their own engineering discipline.

PO–2: 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:

Practical application of engineering skills through combining theory and experience Use of other relevant knowledge and skills in fulfilling this objective, including:

- Knowledge of material characteristics, equipment, processes, or products
- Workshop and laboratory skills
- Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology development, etc.)
- Understanding use of technical literature and other sources of information
- Awareness of nature of intellectual property and contractual issues
- Understanding of appropriate codes of practice and industry standards
- Awareness of quality issues
- Ability to work with technical uncertainty
- Understanding of engineering principles and ability to apply them to analyze key engineering processes
- Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques
- Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems
- Understanding ability to apply a systems approach to engineering problems

PO-3: 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:

Design is the creation and development of an economically viable product, process or system to meet a defined application. It involves significant technical and intellectual skills that can be used, to integrate all engineering understanding, knowledge for the solution of real problems. Graduates will therefore need the knowledge, understanding and skills to:

- 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.
- Knowledge and understanding of commercial and economic context of engineering Processes.
- Knowledge of management techniques which may be used to achieve engineering objectives within that context.
- Understanding of the requirement for engineering activities to promote sustainable development.
- Awareness of the framework of relevant legal requirements governing engineering activities including personnel, health, safety and Environmental (HSE) risks.

PO–4: 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:

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

As the most engineers eventually learn, the problem solving process is never complete. Therefore, a final element here is feedback and improvement.

PO-5: 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:

- Encompasses a wide range of tools and skills needed by engineering graduates in computer software, simulation packages, diagnostic equipment, use of technical library resources and literature search tools.

PO-6: 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:

- Ability to make informed ethical choices and knowledge ability to of professional codes of ethics. Evaluates the ethical dimensions of professional practice and demonstrates ethical behavior.
- High degree of trust and integrity

PO-7: 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:

- Focusing the knowledge and interpretation a socio economic, political and environmental issues.
- Obtaining in-depth knowledge on contemporary issue.

PO-8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. Create a plan for success that connects their college education to future career.

Performance Criteria Definitions:

- Graduates ready for immediate employment.
- Make a smooth transition into post graduate studies

PO - 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Performance Criteria Definitions:

- Maturity – requiring only the achievement of goals to drive their performance.
- Self-direction (take a vaguely defined problem and systematically work to resolution).
- Teams are used during the classroom periods, in the hands-on labs and in the design projects.
- Some teams change for eight-week industry oriented Mini-Project, and for the seventeen – week Design project.
- Instruction on effective teamwork and project management is provided along with an appropriate text book for reference.
- Teamwork is important not only for helping the students and to know their classmates but also in completing assignments.
- Students also are responsible for evaluating each other's performance, which is then reflected in the final grade.
- Ability to demonstrated and work with all levels of people an a team in organization.

PO -10: 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

I. **Written Communication: "**Students should demonstrate the ability to communicate effectively in writing".
   - Clarity.
   - Grammar/Punctuation
   - References

II. **Verbal Communication:** "Students should demonstrate the ability to communicate effectively orally."
   - Speaking Style.
   - Subject Matter.

PO -11: 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:

Inspire the students to further explore in his/her program to recognize the need for life-long Learning. Some aspects of life-long learning include:

- Knowledge and understanding of commercial and economic context of engineering processes.
- Knowledge of managerial techniques which may be used to achieve engineering objectives within that context.
- Understanding of the requirement for engineering activities to promote sustainable development.
- Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues.
- Personal continuing education efforts.
- Understanding of the need for a high level of professional and ethical conduct in engineering.

PO-12: 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:

- Project management professional certification.
- Begin work on advanced degree.
- Updating the knowledge, related to advanced electrical engineering concepts.
- Personal continuing education efforts.
- Ongoing learning – stays up with industry trends/ new technology.
- Continued personal development.
- Have learned same new significant skills.
- Have taken up to 80 hours training per year.

PROGRAM SPECIFIC OUTCOMES OF (B. Tech) EEE GRADUATES

Graduates from accredited program must achieve the following learning outcomes, defined by Broad areas of learning.

PSO-1: Problem-Solving Skills: Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based

Performance Criteria Definitions:

- Limits on type of transmission can be understood.
- The insulation technology plays major rule in high voltage engineering.
- The process of ionization majority contributed to the power system.
- The new techniques can be evolved for the generation of high voltage.
- The curiosity towards material science will step ahead.

PSO-2: Professional Skills: Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their Professional development and gain sufficient competence to solve the current and future energy problems universally.

Performance Criteria Definitions:

- One can work on the resources used to generate electricity.
- Can compare the different electricity generating sources.
- Can works toward the new concept called is distribution generation.
- The scope for installing mini - scale individual power plant can be increases.
- The vision of rural power development increase.
- Ultimately the research work towards developed nation can increase.

PSO-3: Modern Tools In Electrical Engineering: The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.

Performance Criteria Definitions:

- The real time automation techniques required.
- The design analysis, installation and testing of power system components can be made easy automation techniques.
- Good grip on automation electrical system lags the path per good opportunities for carrier.
- In the Entrepreneurship point of view, nowadays must be the electrical application or automated, this leads to individual entrepreneurship.
- The automation mission interface increase scope of research and developing by deferent application.

Faculty Objectives:

F1: Prepare graduates for personal and professional success with awareness of and commitment to their ethical and social responsibilities, both as individuals and in team environments.

F2: Enable graduates to keep on self- development throughout their careers.

F3: Produce graduates with the necessary background and technical skills to work professionally and fulfill the need of industry.

F4: Organize, in collaboration with stakeholders, conferences, symposia and workshops to upgrade technical and scientific levels in Electrical and Electronic Engineering

F5: Carry out and publish academic knowledge.

F6: Activities to promote research innovation, commercialization and Entrepreneurship Increase.

Program Outcomes and Program Specific outcomes Attained through course modules:

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

Code	Subject	PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I Semester B.Tech																
AHS002	Linear Algebra and Ordinary Differential Equations	X	X		X									X		
AHS003	Computational Mathematics and Integral Calculus	X	X		X									X		
AHS006	Engineering Physics	X	X		X									X		
AHS005	Engineering Chemistry	X	X					X						X		
ACS001	Computer Programming	X	X	X	X	X					X	X				
AHS104	Engineering Physics and Chemistry Laboratory	X	X		X					X	X	X		X	X	
ACS101	Computer Programming Laboratory	X	X	X	X											X
AME103	Computer Aided Engineering Drawing	X	X	X		X				X	X	X		X	X	
II Semester B.Tech																
AHS001	English for Communication									X	X		X		X	
AHS011	Mathematical Transform Techniques	X	X		X									X		
AHS009	Environmental Studies	X		X		X		X						X		
ACS002	Data Structures	X	X	X	X	X					X	X		X	X	X
AEE002	Electrical Circuits	X	X	X												X
AHS101	Communication Skills Laboratory										X	X	X		X	
ACS102	Data Structures Laboratory	X	X	X	X											X
AEE102	Electrical Circuits Laboratory	X			X	X				X	X	X		X		X
ACS112	Engineering Practice Laboratory										X	X	X		X	
III Semester B.Tech																
AEE003	Power Generation Systems	X	X				X	X	X			X	X	X	X	
AEE004	DC Machines and Transformers	X	X	X	X									X	X	
AEE005	Network Analysis	X	X	X		X								X		
AEE006	Electromagnetic Field Theory	X	X	X		X								X		
AEC001	Electronic Devices and Circuits	X	X	X	X	X								X		
AHS017	Gender Sensitivity							X	X		X					
AEE104	DC Machines Laboratory	X			X	X				X	X	X		X		X
AEE105	Electrical Engineering Simulation Laboratory	X			X	X				X	X	X		X		X
AEC113	Electronic Circuits Laboratory	X	X			X						X	X	X		X
IV Semester B.Tech																
AEE007	AC Machines	X	X		X									X	X	
AEE008	Electrical Measurements and Instrumentation	X	X	X	X									X	X	
AEC019	Digital and Pulse Circuits	X	X			X				X	X		X	X		
AEE009	Control Systems	X	X	X	X	X								X	X	
AHS004	Complex Analysis and Probability Distributions	X	X	X	X	X							X	X		
AEE106	AC Machines Laboratory	X			X	X				X	X	X		X		X
AEE107	Electrical Measurements and Instrumentation Laboratory	X		X	X	X				X	X	X		X		X
AEE115	Control Systems and Simulation Laboratory	X		X	X	X				X	X	X		X		X

V Semester B.Tech															
AEC008	Integrated Circuits Applications	X	X	X	X	X				X	X		X			
AEE010	Power Electronics	X	X	X										X	X	
AHS012	Optimization Techniques	X	X	X	X	X					X		X	X		
AEE011	Transmission and Distribution Systems	X	X	X			X					X		X	X	
AHS015	Business Economics and Financial Analysis	X	X	X			X			X		X	X	X	X	
AHS106	Research and Content Development Laboratory	X	X			X				X	X	X	X	X	X	X
AEE108	Power Electronics and Simulation Laboratory	X			X	X				X	X	X		X		X
AEC106	Integrated Circuits Applications Laboratory	X	X			X						X	X	X		X
VI Semester B.Tech																
AEE012	Power System Analysis	X	X	X		X								X	X	
AEE013	Solid State Electric Motor Drives	X	X	X	X									X	X	
AEC021	Microcontrollers and Digital Signal Processing		X	X		X								X		X
AEE109	Solid State Electric Motor Drives Laboratory	X			X	X				X	X	X		X		X
AEE110	PLC and Automation Laboratory	X		X	X	X				X	X	X		X		X
AEC114	Microcontrollers and Digital Signal Processing Laboratory		X	X	X	X				X	X	X	X	X		X
AEE201	Mini Project	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
VII Semester B.Tech																
AEE014	Power System Protection	X	X				X					X		X	X	
AEE015	High Voltage Engineering	X		X	X									X	X	
AEE016	Power System Operation and Control	X	X	X		X							X	X	X	
AEE111	High Voltage Engineering and Solar Laboratory	X	X		X	X				X	X	X		X	X	X
AEE112	Power System Protection Laboratory	X	X		X					X	X	X		X		X
AEE113	Power System Computer Aided Design Laboratory	X			X	X				X	X	X		X		X
AEE301	Project Work (Phase - I)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
VIII Semester B.Tech																
AEC017	Embedded Systems	X	X			X						X		X		X
AEE017	Hybrid Electric Vehicles	X	X				X	X						X		X
AEE401	Comprehensive Examination	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
AEE302	Project Work (Phase - II)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PROFESSIONAL ELECTIVE – I																
AEE502	Power System Transients	X	X	X										X	X	
AEE503	Energy Audit and Management	X	X	X	X		X		X	X			X	X	X	
PROFESSIONALELECTIVE–II																
AEE506	Power Electronics for Renewable Energy Systems	X	X	X			X	X	X					X	X	
AEE509	Power Quality	X	X	X										X	X	
PROFESSIONALELECTIVE – III																
AEE511	Industrial Automation and Control	X	X	X		X								X		X
AEE513	Power Systems Stability	X	X	X		X								X	X	
AEE522	Energy Management Systems and SCADA		X	X	X	X	X						X	X	X	X
PROFESSIONALELECTIVE – IV																
AEE516	Power Plant Control and Instrumentation	X	X	X	X									X	X	
AEE520	Modern Control Theory	X	X	X	X	X								X		
AEE524	Flexible Alternating Current Transmission Systems	X	X	X			X							X		

AEE526	Special Electrical Machines	X	X										X	X	
AEE528	Modeling and Analysis of Electrical Machines	X	X	X	X	X							X	X	
OPEN ELECTIVE-I															
ACS007	Operating System	X	X	X		X				X	X				X
ACS003	Object Oriented Program Through JAVA	X	X	X	X	X				X	X				X
AEC551	Signal Analysis And Transformation Techniques	X	X	X									X		
ACE551	Disaster Management	X	X				X	X	X			X			X	
OPEN ELECTIVE-II															
AEE551	Energy From Waste						X	X	X			X	X		X	
ACS005	Database Management Systems	X	X	X	X	X					X	X				X
AEC508	Digital Image Processing	X	X	X										X		
AHS551	Modeling And Simulation		X	X		X					X			X		
AUDIT COURSES																
AHS601	Intellectual Property Rights						X	X	X	X	X	X	X		X	
AHS603	Professional Ethics And Human Values						X	X	X	X	X	X	X		X	
AHS017	Gender Sensitivity							X	X		X					

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

Code	Subject	Code	Subject
PO1: **Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.**			
I Semester		**V Semester**	
AHS002	Linear Algebra and Ordinary Differential Equations	AEC008	Integrated Circuits Applications
AHS003	Computational Mathematics and Integral Calculus	AEE010	Power Electronics
AHS006	Engineering Physics	AHS012	Optimization Techniques
AHS005	Engineering Chemistry	AEE011	Transmission and Distribution Systems
ACS001	Computer Programming	AHS015	Business Economics and Financial Analysis
AHS104	Engineering Physics and Chemistry Laboratory	AHS106	Research and Content Development Laboratory
ACS101	Computer Programming Laboratory	AEE108	Power Electronics and Simulation Laboratory
AME103	Computer Aided Engineering Drawing	AEC106	Integrated Circuits Applications Laboratory
II Semester		**VI Semester**	
		AEE012	Power System Analysis
AHS011	Mathematical Transform Techniques	AEE013	Solid State Electric Motor Drives
AHS009	Environmental Studies		
ACS002	Data Structures	AEE109	Solid State Electric Motor Drives Laboratory
AEE002	Electrical Circuits	AEE110	PLC and Automation Laboratory

Code	Subject	Code	Subject
ACS102	Data Structures Laboratory	AEE201	Mini Project
AEE102	Electrical Circuits Laboratory	**VII Semester**	
		AEE014	Power System Protection
III Semester		AEE015	High Voltage Engineering
AEE003	Power Generation Systems	AEE016	Power System Operation and Control
AEE004	DC Machines and Transformers	AEE111	High Voltage Engineering and Solar Laboratory
AEE005	Network Analysis	AEE112	Power System Protection Laboratory
AEE006	Electromagnetic Field Theory	AEE113	Power System Computer Aided Design Laboratory
AEC001	Electronic Devices and Circuits	AEE301	Project Work (Phase - I)
		VIII Semester	
AEE104	DC Machines Laboratory	AEC017	Embedded Systems
AEE105	Electrical Engineering Simulation Laboratory	AEE017	Hybrid Electric Vehicles
AEC113	Electronic Circuits Laboratory	AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
AEE007	AC Machines	**Electives**	
AEE008	Electrical Measurements and Instrumentation	AEE502	Power System Transients
AEC019	Digital and Pulse Circuits	AEE503	Energy Audit and Management
AEE009	Control Systems	AEE506	Power Electronics for Renewable Energy Systems
AHS004	Complex Analysis and Probability Distributions	AEE509	Power Quality
AEE106	AC Machines Laboratory	AEE511	Industrial Automation and Control
AEE107	Electrical Measurements and Instrumentation Laboratory	AEE513	Power Systems Stability
AEE115	Control Systems and Simulation Laboratory	AEE516	Power Plant Control and Instrumentation
		AEE520	Modern Control Theory
		AEE524	Flexible Alternating Current Transmission Systems
		AEE526	Special Electrical Machines
		AEE528	Modeling and Analysis of Electrical Machines
		ACS007	Operating System
		ACS003	Object Oriented Program Through JAVA
		AEC551	Signal Analysis And Transformation Techniques
		ACE551	Disaster Management
		ACS005	Database Management Systems
		AEC508	Digital Image Processing

Code	Subject	Code	Subject
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.**			
I Semester		**V Semester**	
AHS002	Linear Algebra and Ordinary Differential Equations	AEC008	Integrated Circuits Applications
AHS003	Computational Mathematics and Integral Calculus	AEE010	Power Electronics
AHS006	Engineering Physics	AHS012	Optimization Techniques
AHS005	Engineering Chemistry	AEE011	Transmission and Distribution Systems
ACS001	Computer Programming	AHS015	Business Economics and Financial Analysis
AHS104	Engineering Physics and Chemistry Laboratory	AHS106	Research and Content Development Laboratory
ACS101	Computer Programming Laboratory		
AME103	Computer Aided Engineering Drawing	AEC106	Integrated Circuits Applications Laboratory
II Semester		**VI Semester**	
AHS001	English for Communication	AEE012	Power System Analysis
AHS011	Mathematical Transform Techniques	AEE013	Solid State Electric Motor Drives
AHS009	Environmental Studies		
ACS002	Data Structures	AEE109	Solid State Electric Motor Drives Laboratory
AEE002	Electrical Circuits	AEE110	PLC and Automation Laboratory
ACS102	Data Structures Laboratory	AEE201	Mini Project
		VII Semester	
		AEE014	Power System Protection
III Semester			
AEE003	Power Generation Systems	AEE016	Power System Operation and Control
AEE004	DC Machines and Transformers	AEE111	High Voltage Engineering and Solar Laboratory
AEE005	Network Analysis	AEE112	Power System Protection Laboratory
AEE006	Electromagnetic Field Theory		
AEC001	Electronic Devices and Circuits	AEE301	Project Work (Phase - I)
		VIII Semester	
		AEC017	Embedded Systems
		AEE017	Hybrid Electric Vehicles
AEC113	Electronic Circuits Laboratory	AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
AEE007	AC Machines	**Electives**	
AEE008	Electrical Measurements and Instrumentation	AEE502	Power System Transients

Code	Subject	Code	Subject
AEC019	Digital and Pulse Circuits	AEE503	Energy Audit and Management
AEE009	Control Systems	AEE506	Power Electronics for Renewable Energy Systems
AHS004	Complex Analysis and Probability Distributions	AEE509	Power Quality
		AEE511	Industrial Automation and Control
		AEE513	Power Systems Stability
AEE115	Control Systems and Simulation Laboratory	AEE522	Energy Management Systems and SCADA
		AEE516	Power Plant Control and Instrumentation
		AEE520	Modern Control Theory
		AEE524	Flexible Alternating Current Transmission Systems
		AEE526	Special Electrical Machines
		AEE528	Modeling and Analysis of Electrical Machines
		ACS007	Operating System
		ACS003	Object Oriented Program Through JAVA
		AEC551	Signal Analysis And Transformation Techniques
		ACE551	Disaster Management
		ACS005	Database Management Systems
		AEC508	Digital Image Processing
		AHS551	Modeling And Simulation

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.

	I Semester		V Semester
AHS002	Linear Algebra and Ordinary Differential Equations	AEC008	Integrated Circuits Applications
AHS003	Computational Mathematics and Integral Calculus	AEE010	Power Electronics
AHS006	Engineering Physics	AHS012	Optimization Techniques
AHS005	Engineering Chemistry	AEE011	Transmission and Distribution Systems
ACS001	Computer Programming	AHS015	Business Economics and Financial Analysis
ACS101	Computer Programming Laboratory		
AME103	Computer Aided Engineering Drawing		
	II Semester		**VI Semester**
		AEE012	Power System Analysis
AHS011	Mathematical Transform Techniques	AEE013	Solid State Electric Motor Drives
AHS009	Environmental Studies	AEC021	Microcontrollers and Digital Signal Processing
ACS002	Data Structures		

Code	Subject	Code	Subject
AEE002	Electrical Circuits	AEE110	PLC and Automation Laboratory
		AEC114	Microcontrollers and Digital Signal Processing Laboratory
ACS102	Data Structures Laboratory	AEE201	Mini Project
		VII Semester	
III Semester		AEE015	High Voltage Engineering
		AEE016	Power System Operation and Control
AEE004	DC Machines and Transformers		
AEE005	Network Analysis		
AEE006	Electromagnetic Field Theory		
AEC001	Electronic Devices and Circuits	AEE301	Project Work (Phase - I)
			VIII Semester
		AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
			Electives
AEE008	Electrical Measurements and Instrumentation	AEE502	Power System Transients
AEC019	Digital and Pulse Circuits	AEE503	Energy Audit and Management
AEE009	Control Systems	AEE506	Power Electronics for Renewable Energy Systems
AHS004	Complex Analysis and Probability Distributions	AEE509	Power Quality
		AEE511	Industrial Automation and Control
AEE107	Electrical Measurements and Instrumentation Laboratory	AEE513	Power Systems Stability
AEE115	Control Systems and Simulation Laboratory	AEE522	Energy Management Systems and SCADA
		AEE516	Power Plant Control and Instrumentation
		AEE520	Modern Control Theory
		AEE524	Flexible Alternating Current Transmission Systems
		AEE528	Modeling and Analysis of Electrical Machines
		ACS007	Operating System
		ACS003	Object Oriented Program Through JAVA
		AEC551	Signal Analysis And Transformation Techniques
		ACS005	Database Management Systems
		AEC508	Digital Image Processing
		AHS551	Modeling And Simulation

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.

Code	Subject	Code	Subject
I Semester		**V Semester**	
		AEC008	Integrated Circuits Applications
		AEE010	Power Electronics
		AHS012	Optimization Techniques
ACS001	Computer Programming		
AHS104	Engineering Physics and Chemistry Laboratory		
ACS101	Computer Programming Laboratory	AEE108	Power Electronics and Simulation Laboratory
II Semester		**VI Semester**	
AHS011	Mathematical Transform Techniques	AEE013	Solid State Electric Motor Drives
ACS002	Data Structures	AEE109	Solid State Electric Motor Drives Laboratory
		AEE110	PLC and Automation Laboratory
		AEC114	Microcontrollers and Digital Signal Processing Laboratory
ACS102	Data Structures Laboratory	AEE201	Mini Project
AEE102	Electrical Circuits Laboratory	**VII Semester**	
III Semester		AEE015	High Voltage Engineering
AEE003	Power Generation Systems		
AEE004	DC Machines and Transformers	AEE111	High Voltage Engineering and Solar Laboratory
		AEE112	Power System Protection Laboratory
		AEE113	Power System Computer Aided Design Laboratory
AEC001	Electronic Devices and Circuits	AEE301	Project Work (Phase - I)
		VIII Semester	
AEE104	DC Machines Laboratory		
AEE105	Electrical Engineering Simulation Laboratory		
		AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
AEE007	AC Machines	**Electives**	
AEE008	Electrical Measurements and Instrumentation	AEE503	Energy Audit and Management
		AEE522	Energy Management Systems and SCADA
AEE009	Control Systems	AEE516	Power Plant Control and Instrumentation
AHS004	Complex Analysis and Probability Distributions	AEE520	Modern Control Theory

Code	Subject	Code	Subject
AEE106	AC Machines Laboratory	AEE528	Modeling and Analysis of Electrical Machines
AEE107	Electrical Measurements and Instrumentation Laboratory	ACS003	Object Oriented Program Through JAVA
AEE115	Control Systems and Simulation Laboratory	ACS005	Database Management 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.

I Semester		V Semester	
AHS002	Linear Algebra and Ordinary Differential Equations	AEC008	Integrated Circuits Applications
AHS003	Computational Mathematics and Integral Calculus		
		AHS012	Optimization Techniques
ACS001	Computer Programming		
		AHS106	Research and Content Development Laboratory
		AEE108	Power Electronics and Simulation Laboratory
AME103	Computer Aided Engineering Drawing	AEC106	Integrated Circuits Applications Laboratory
II Semester		**VI Semester**	
		AEE012	Power System Analysis
AHS011	Mathematical Transform Techniques		
		AEC021	Microcontrollers and Digital Signal Processing
ACS002	Data Structures	AEE109	Solid State Electric Motor Drives Laboratory
		AEE110	PLC and Automation Laboratory
		AEC114	Microcontrollers and Digital Signal Processing Laboratory
		AEE201	Mini Project
AEE102	Electrical Circuits Laboratory	**VII Semester**	
III Semester			
		AEE016	Power System Operation and Control
		AEE111	High Voltage Engineering and Solar Laboratory
AEE005	Network Analysis		
AEE006	Electromagnetic Field Theory	AEE113	Power System Computer Aided Design Laboratory
AEC001	Electronic Devices and Circuits	AEE301	Project Work (Phase - I)
		VIII Semester	
AEE104	DC Machines Laboratory	AEC017	Embedded Systems

Code	Subject	Code	Subject
AEE105	Electrical Engineering Simulation Laboratory		
AEC113	Electronic Circuits Laboratory	AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
		Electives	
		AEE511	Industrial Automation and Control
AEC019	Digital and Pulse Circuits	AEE513	Power Systems Stability
AEE009	Control Systems	AEE522	Energy Management Systems and SCADA
AHS004	Complex Analysis and Probability Distributions	AEE520	Modern Control Theory
AEE106	AC Machines Laboratory	AEE528	Modeling and Analysis of Electrical Machines
AEE107	Electrical Measurements and Instrumentation Laboratory	ACS007	Operating System
AEE115	Control Systems and Simulation Laboratory	ACS003	Object Oriented Program Through JAVA
		ACS005	Database Management Systems
		AHS551	Modeling And Simulation

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.

I Semester		V Semester	
		AEE011	Transmission and Distribution Systems
		AHS015	Business Economics and Financial Analysis
II Semester		**VI Semester**	
		AEE201	Mini Project
		VII Semester	
		AEE014	Power System Protection
III Semester			
AEE003	Power Generation Systems		
		AEE301	Project Work (Phase - I)
		VIII Semester	
		AEE017	Hybrid Electric Vehicles
		AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
		Electives	
		AEE503	Energy Audit and Management
		AEE506	Power Electronics for Renewable Energy Systems
		AEE522	Energy Management Systems and SCADA

Code	Subject	Code	Subject
		AEE524	Flexible Alternating Current Transmission Systems
		ACE551	Disaster Management
		AEE551	Energy From Waste
		AHS601	Intellectual Property Rights
		AHS603	Professional Ethics And Human Values
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.**			
I Semester		**V Semester**	
AHS005	Engineering Chemistry		
II Semester		**VI Semester**	
AHS009	Environmental Studies		
		AEE201	Mini Project
		VII Semester	
III Semester			
AEE003	Power Generation Systems		
		AEE301	Project Work (Phase - I)
AHS017	Gender Sensitivity	**VIII Semester**	
		AEE017	Hybrid Electric Vehicles
		AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
		Electives	
		AEE506	Power Electronics for Renewable Energy Systems
		ACE551	Disaster Management
		AEE551	Energy From Waste
		AHS601	Intellectual Property Rights
		AHS603	Professional Ethics And Human Values
		AHS017	Gender Sensitivity
PO8: **Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.**			
I Semester		**V Semester**	
II Semester		**VI Semester**	
AHS001	English for Communication		
AHS101	Communication Skills Laboratory		
		AEE201	Mini Project

Code	Subject	Code	Subject
		VII Semester	
III Semester			
AEE003	Power Generation Systems		
		AEE301	Project Work (Phase - I)
AHS017	Gender Sensitivity	**VIII Semester**	
		AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
		Electives	
		AEE503	Energy Audit and Management
		AEE506	Power Electronics for Renewable Energy Systems
		ACE551	Disaster Management
		AEE551	Energy From Waste
		AHS601	Intellectual Property Rights
		AHS603	Professional Ethics And Human Values
		AHS017	Gender Sensitivity
PO9: **Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.**			
I Semester		**V Semester**	
		AEC008	Integrated Circuits Applications
		AHS015	Business Economics and Financial Analysis
AHS104	Engineering Physics and Chemistry Laboratory	AHS106	Research and Content Development Laboratory
		AEE108	Power Electronics and Simulation Laboratory
AME103	Computer Aided Engineering Drawing		
II Semester		**VI Semester**	
AHS001	English for Communication		
		AEE109	Solid State Electric Motor Drives Laboratory
		AEE110	PLC and Automation Laboratory
AHS101	Communication Skills Laboratory	AEC114	Microcontrollers and Digital Signal Processing Laboratory
		AEE201	Mini Project
		VII Semester	
III Semester			
		AEE111	High Voltage Engineering and Solar Laboratory
		AEE112	Power System Protection Laboratory
		AEE113	Power System Computer Aided Design Laboratory
		AEE301	Project Work (Phase - I)

Code	Subject	Code	Subject
		VIII Semester	
AEE104	DC Machines Laboratory		
AEE105	Electrical Engineering Simulation Laboratory		
		AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
		Electives	
		AEE503	Energy Audit and Management
AEC019	Digital and Pulse Circuits	AHS601	Intellectual Property Rights
		AHS603	Professional Ethics And Human Values
AEE106	AC Machines Laboratory		
AEE107	Electrical Measurements and Instrumentation Laboratory		
AEE115	Control Systems and Simulation Laboratory		

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.

I Semester		V Semester	
		AEC008	Integrated Circuits Applications
		AHS012	Optimization Techniques
ACS001	Computer Programming		
AHS104	Engineering Physics and Chemistry Laboratory	AHS106	Research and Content Development Laboratory
		AEE108	Power Electronics and Simulation Laboratory
AME103	Computer Aided Engineering Drawing		
II Semester		VI Semester	
AHS001	English for Communication		
AHS011	Mathematical Transform Techniques		
ACS002	Data Structures	AEE109	Solid State Electric Motor Drives Laboratory
		AEE110	PLC and Automation Laboratory
AHS101	Communication Skills Laboratory	AEC114	Microcontrollers and Digital Signal Processing Laboratory
		AEE201	Mini Project
AEE102	Electrical Circuits Laboratory	VII Semester	
ACS112	Engineering Practice Laboratory		
III Semester			

Code	Subject	Code	Subject
		AEE111	High Voltage Engineering and Solar Laboratory
		AEE112	Power System Protection Laboratory
		AEE113	Power System Computer Aided Design Laboratory
		AEE301	Project Work (Phase - I)
AHS017	Gender Sensitivity	**VIII Semester**	
AEE104	DC Machines Laboratory		
AEE105	Electrical Engineering Simulation Laboratory		
		AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
		Electives	
		ACS007	Operating System
AEC019	Digital and Pulse Circuits	ACS003	Object Oriented Program Through JAVA
		ACS005	Database Management Systems
		AHS551	Modeling And Simulation
AEE106	AC Machines Laboratory	AHS601	Intellectual Property Rights
AEE107	Electrical Measurements and Instrumentation Laboratory	AHS603	Professional Ethics And Human Values
AEE115	Control Systems and Simulation Laboratory	AHS017	Gender Sensitivity

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.

I Semester		**V Semester**	
AHS002	Linear Algebra and Ordinary Differential Equations		
AHS003	Computational Mathematics and Integral Calculus		
AHS006	Engineering Physics		
AHS005	Engineering Chemistry	AEE011	Transmission and Distribution Systems
ACS001	Computer Programming	AHS015	Business Economics and Financial Analysis
AHS104	Engineering Physics and Chemistry Laboratory	AHS106	Research and Content Development Laboratory
		AEE108	Power Electronics and Simulation Laboratory
AME103	Computer Aided Engineering Drawing	AEC106	Integrated Circuits Applications Laboratory
II Semester		**VI Semester**	
AHS001	English for Communication		
AHS009	Environmental Studies		
		AEE109	Solid State Electric Motor Drives Laboratory
AEE002	Electrical Circuits	AEE110	PLC and Automation Laboratory

Code	Subject	Code	Subject
AHS101	Communication Skills Laboratory	AEC114	Microcontrollers and Digital Signal Processing Laboratory
		AEE201	Mini Project
AEE102	Electrical Circuits Laboratory	**VII Semester**	
ACS112	Engineering Practice Laboratory	AEE014	Power System Protection
III Semester			
AEE003	Power Generation Systems		
		AEE111	High Voltage Engineering and Solar Laboratory
		AEE112	Power System Protection Laboratory
		AEE113	Power System Computer Aided Design Laboratory
		AEE301	Project Work (Phase - I)
		VIII Semester	
AEE104	DC Machines Laboratory	AEC017	Embedded Systems
AEE105	Electrical Engineering Simulation Laboratory		
AEC113	Electronic Circuits Laboratory	AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
		Electives	
		ACS007	Operating System
		ACS003	Object Oriented Program Through JAVA
		ACE551	Disaster Management
		AEE551	Energy From Waste
AEE106	AC Machines Laboratory	ACS005	Database Management Systems
AEE107	Electrical Measurements and Instrumentation Laboratory	AHS601	Intellectual Property Rights
AEE115	Control Systems and Simulation Laboratory	AHS603	Professional Ethics And Human Values

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.

I Semester		V Semester	
		AEC008	Integrated Circuits Applications
		AHS012	Optimization Techniques
		AHS015	Business Economics and Financial Analysis
		AHS106	Research and Content Development Laboratory
		AEC106	Integrated Circuits Applications Laboratory
II Semester		**VI Semester**	
AHS101	Communication Skills Laboratory	AEC114	Microcontrollers and Digital Signal Processing Laboratory

Code	Subject	Code	Subject
		AEE201	Mini Project
		VII Semester	
ACS112	Engineering Practice Laboratory		
III Semester			
AEE003	Power Generation Systems	AEE016	Power System Operation and Control
		AEE301	Project Work (Phase - I)
		VIII Semester	
AEC113	Electronic Circuits Laboratory	AEE401	Comprehensive Examination
IV Semester		AEE302	Project Work (Phase - II)
		Electives	
		AEE503	Energy Audit and Management
AEC019	Digital and Pulse Circuits	AEE522	Energy Management Systems and SCADA
		AEE551	Energy From Waste
AHS004	Complex Analysis and Probability Distributions	AHS601	Intellectual Property Rights
		AHS603	Professional Ethics And Human Values

The classification of Program Specific outcomes of the above Electrical and Electronics Engineering Courses are grouped as follows:

PSO1:
Professional Skills: Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based.

Code	Subject	Code	Subject
I Year		**III B.Tech I Semester**	
A10002	Mathematics-I	A50221	Power Systems - II
A10003	Mathematical Methods	A50218	Electrical Machines-III
A10004	Engineering Physics	A50289	Electrical Machines lab - II
A10501	Computer Programming	**III B.Tech II Semester**	
A10083	English Language Communication Skills lab	A60223	Electrical and Electronic Instrumentation
A10081	Engineering Physics and Engineering Chemistry Lab	A60225	Static Drives
A10581	Computer Programming Lab	A60222	Computer Methods In Power Systems
II B.Tech I Semester		**IV B.Tech I Semester**	
A30007	Mathematics - III	A70231	Switch Gear Protection
A30102	Fluid Mechanics And Hydraulic Machines	A70232	Utilization of Electrical Energy
A30403	Electro-Magnetic Fields	A70230	Power System Operation And Control
A30206	Electrical Machines-I	A70293	Electrical Measurements lab
II B.Tech II Semester			
A40212	Electrical Machines - II		

A40287	Electrical Machines lab - I		
A40286	Electrical Circuits And Simulation lab		

PSO2:
Problem-Solving Skills: Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.

Code	Subject	Code	Subject
I Year		A40287	Electrical Machines lab - I
A10001	English	A40286	Electrical Circuits And Simulation lab
A10002	Mathematics-I	**III B.Tech I Semester**	
A10005	Engineering Chemistry	A50221	Power Systems - II
A10501	Computer Programming	A50211	Control Systems
A10301	Engineering Drawing	A50220	Power Electronics
A10081	Engineering Physics and Engineering Chemistry Lab	A50218	Electrical Machines-III
A10581	Computer Programming Lab	A50289	Electrical Machines lab - II
II B.Tech I Semester		**III B.Tech II Semester**	
A30007	Mathematics - III	A60225	Static Drives
A30404	Electronic Devices And Circuits'	A60222	Computer Methods In Power Systems
A30204	Electrical Circuits	A60290	Control System And Simulation lab
A30403	Electro-Magnetic Fields	A60291	Power Electronics And Simulation lab
A30206	Electrical Machines-I	**IV B.Tech I Semester**	
A30181	Fluid mechanics And Hydraulic Machines lab	A70231	Switch Gear Protection
A30482	Electronic Devices And Circuits lab	A70232	Utilization of Electrical Energy
II B.Tech II Semester		A70421	Digital Signal Processing
A40214	Power Systems - I	A70230	Power System Operation And Control
A40413	Electronics Circuits	A70293	Electrical Measurements lab
A40407	Switching Theory And Logic Design	A70498	Microprocessor And Interfacing Devices lab
A40213	Network Theory		

PSO3:
Successful Career and Entrepreneurship: The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.

Code	Subject	Code	Subject
I Year		A50211	Control Systems
A10001	English	A50220	Power Electronics
A10002	Mathematics-I	A50086	Advanced Communication Skills lab
A10003	Mathematical Methods	**III B.Tech II Semester**	
A10004	Engineering Physics	A60430	Microprocessor And Interfacing Devices
A10005	Engineering Chemistry	A60009	Environmental Studies

A10301	Engineering Drawing	A60290	Control System And Simulation lab
A10083	English Language Communication Skills lab	A60291	Power Electronics And Simulation lab
A10082	IT workshop/ Engineering Workshop	A60018	Human Values And Professional Ethics
II B.Tech I Semester		**IV B.Tech I Semester**	
A30102	Fluid Mechanics And Hydraulic Machines	A70421	Digital Signal Processing
A30404	Electronic Devices And Circuits'	A70498	Microprocessor And Interfacing Devices lab
II B.Tech II Semester		A70226	Electrical Distribution Systems
A40010	Managerial Economics & Financial Analysis	A70432	VLSI Design
A40214	Power Systems - I	A70435	Digital Control Systems
A40413	Electronics Circuits	A1227	Optimization Techniques
III B.Tech I Semester		**IV B.Tech II Semester**	
A50423	IC Applications	A80234	Renewable energy sources
A50014	Management Science	A80234	Advanced control systems

8. METHODSOFMEASURINGLEARNINGOUTCOMESANDVALUEADDITION:

There are many different ways to assess student learning. In this section, we present the different types of assessment approaches available and the different frame works 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 act a safe licitator 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 port folios from there spective 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 seniors survey form is to be filled by all the students leaving the institution. The questionnaire is designed in such away 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 a sunder graduate 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 e 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 requirement so 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; abroad 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 fortnight 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:

Learning Outcomes are the formal statements of what students are expected to learn in a course. Synonyms for "learning outcome" include expected learning outcome, learning outcome statement, and student learning outcome. Course level student learning outcomes 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 course purpose, expected learning outcomes, methods for assessing expected learning outcomes, criteria for grade determination and a course outline. 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 expect 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 program. The course purpose goes beyond the course description.

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, and 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 program?
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?
6. 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 program.

2. EXPECTED LEARNING OUTCOMES:

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 writing 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). Thesewords 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 Electrical Distribution Systems.
- The students will appreciate knowledge discovery from Distribution Automation 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" Distribution Automation 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 in Distribution Automation systems.
- The students will be able to identify the characteristics of Classification techniques from other Distribution Automation 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
Count	Associate	Add	Analyze	Appraise	Categorize
Define	Compute	Apply	Arrange	Assess	Combine
Describe	Convert	Calculate	Breakdown	Compare	Compile
Draw	Defend	Change	Combine	Conclude	Compose
Identify	Discuss	Classify	Design	Contrast	Create
Label	Distinguish	Complete	Detect	Criticize	Drive
List	Estimate	Compute	Develop	Critique	Design
Match	Explain	Demonstrate	Diagram	Determine	Devise
Name	Extend	Discover	Differentiate	Grade	Explain
Outline	Extrapolate	Divide	Discriminate	Interpret	Generate
Point	Generalize	Examine	Illustrate	Judge	Group
Quote	Give	Graph	Infer	Justify	Integrate
Read	Examples	Interpolate	Outline	Measure	Modify
Recall	Infer	Manipulate	Point out	Rank	Order
Recite	Paraphrase	Modify	Relate	Rate	Organize
Recognize	Predict	Operate	Select	Support	Plan
Record	Rewrite	Prepare	Separate	Test	Prescribe
Repeat	Summarize	Produce	Subdivide		Propose
Reproduce		Show	Utilize		Rearrange
Select		Solve			Reconstruct
State Write		Subtract			Related
		Translate			Reorganize
		Use			Revise
					Rewrite
					Summarize
					Transform
					Specify

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 names of all *Distribution Automation Techniques* versus

- "one objective of this course is to teach the names of all *Distribution Automation 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.

Electrical Circuits
At the end of the course, the student should be able to:

- Define basic electrical concepts, including electric charge, current, electrical potential, electrical Power and energy.
- Distinguish the relationship of voltage and current in resistors, capacitors, inductors, and mutual Inductors.
- Differentiate circuits with ideal, independent, and controlled voltage and current sources and able to apply Kirchhoff's voltage and current laws to the analysis of electric circuits.
- Illustrate to apply concepts of electric network topology, nodes, branches, and loops to solve circuit problems, including the use of computer simulation.
- Capable to analyze electrical circuits thermos

Electrical Machines:
Upon completion of this course, the students will be able to:

- Capable to analyze the principle, Construction and operation of a single phase transformer.
- Proficient with the transformer about the No Load and Load Conditions.
- Development of basic skills in design and analysis of the Equivalent Circuit of a Transformer.
- Acquaint with the star-star, delta –delta, star-delta, delta-star connections of a poly phasor transformer.
- Discriminate the principle, construction and operation of a three phase Induction Motor.
- Interpret the different techniques for the speed control of an Induction Motor.
- Interpolate the performance and torque –slip characteristics of an Induction motor.

Power System:
Upon completion of this course, students will acquire knowledge about:

- Analyze the power system structure and interconnected grid system.
- Compare the applications and significance of both conventional and non-conventional sources.
- Proficient in comparison of different types of generating stations.

- Categorize the different types of substations & its layouts.
- Analyze and perform the tasks of correcting the power factor & voltage control.
- Analyze the power generation economic aspects such as load curves & factor governing the power system performance.
- Evaluate the tariff methods & calculations.

Power System Operation and Control:
After completing this course the student must demonstrate the knowledge and ability to:

- Associate and apply the concept and principle of unit commitment and optimal operation of power plants.
- Estimate the interconnection of power systems networks with two or more streams.
- Assess various methods to obtain the economic operation.
- Proficient in load frequency control of single area and two area networks.
- Identify the steady state and dynamic performance of I area LFC and II area LFC.
- Analyze and perform the tasks of modeling the generator, turbine, and speed governor.
- Compute reactive power control in transmission lines and compensation of reactive power.

6. AN OVERVIEW OF 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 wellthey 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. PG Shastry 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. PG Shastry 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.

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 finalexam). 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.

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 questioner 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:

Determining the PURPOSE of teaching the course:

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 course's standing within the program *(e.g., is the course required or an elective?, does this class have a pre-requisite?, etc.)*. It should also describe the course's role in the departmental/programmatic curriculum by addressing the intent (importance, main contribution, intrinsic value, etc.) of the class.

STEP ONE:
Determine if the course is part of the IEEE / ACM / AICTE Model Curriculum:

A **flexible alternating current transmission system** (FACTS) is a system composed of static equipment used for the AC Transmission of Electrical Energy. It is meant to enhance controllability and increase power transfer capability of the network. It is generally a Power Electronics-based system.

FACTS are defined by the EEE as power electronic based and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increase power transfer capability.

According to Siemens "FACTS, Increase the reliability of AC grids and reduce power delivery costs. They improve transmission quality and efficiency of power transmission by supplying inductive or reactive power to the grid.

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 / ACM / 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 programme outcomes
- Mapping course outcomes leading to the achievement of the programme outcomes

9. REFERENCES:

1. American Association of Law Libraries (2005). Writing learning outcomes. Retrieved May 31, 2005 from http://www.aallnet.org/prodev/outcomes.asp.
2. Anderson, L.W., and Krathwohl, D.R. (Eds.) (2001). Taxonomy of learning, teaching, and assessment: A revision of Bloom's taxonomy of educational objectives. New York: Longman.
3. Angelo, T.A. & Cross, K.P. (1993). Classroom assessment techniques: A handbook for college teachers (2nd Ed.). San Francisco, CA: Jossey-Bass. Ball State University, (1999).
4. Bloom's Classification of Cognitive Skills. Retrieved, June 10, 2005 from http://web.bsu.edu/IRAA/AA/WB/chapter2.htm.
5. Bloom, B.S., (1956) Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain. Longmans, Green: New York, NY.
6. Hales, L.W. & Marshall, J.C. (2004). Developing effective assessments to improve teaching and learning. Norwood, MA: Christopher-Gordon Publishers, Inc.
7. Huba, M.E., (2005). Formulating intended learning outcomes. Retrieved June 16, 2005 from http://www.viterbo.edu/academic/titleiii/events/files/Jun04/Intended%20Learning%20 Outcomes.ppt#256,1, Formulating Intended Learning Outcomes.
8. Kansas State University, (2004). Assessment of student learning plan. Retrieved May 15, 2005 from http://www.k-state.edu/assessment/Library/templatew.doc.
9. Kansas State University, (2004). Form for identifying strategies and processes for the assessment of student learning outcome(s). Retrieved May 15, 2005 from http://www.k-state.edu/assessment/Library/strategies.pdf.
10. Kansas State University, (2005). How to write student learning outcomes: Action verb List – suggested verbs to use in each level of thinking skills. Retrieved May 15, 2005 from http://www.k-state.edu/assessment/Learning/action.htm.
11. Krumme, G (2001). Major categories in the taxonomy of educational objectives (Bloom 1956). Retrieved June 6, 2005 from http://faculty.washington.edu/krumme /guides / bloom 1Html.
12. Maki, P.L. (2004). Assessing for learning: Building a sustainable commitment across the institution. Stylus: Sterling, VA.
13. Palomba, C.A. & Banta, T.W. Eds. (2001). Assessing student competence in accredited disciplines: Pioneering approaches to assessment in higher education. Stylus: Sterling, VA.
14. Siebold, R. & Beal, M. (May 2005). Online course development guide: The workbook.

Presented at The Teaching Professor Conference in Shaumburg, IL.

15. Suskie, L. (ed) (2001). Assessment to promote deep learning: Insight from AAHE's 2000 and 1999 Assessment Conferences.
16. Suskie, L. (2004). Assessing student learning: A common sense guide. Anker Publishing Company: Bolton, MA.
17. St. Edward's University Center for Teaching Excellence (2004). Task Oriented Question Construction Wheel Based on Bloom's Taxonomy. Retrieved on May 17, 2005 from http://www.stedwards.edu/cte/resources/bwheel.htm.
18. Texas Tech University (2005). Texas Tech University 2005-06 Undergraduate and Graduate Catalog Volume LXXXII. Published by the Office of Official Publications: Lubbock.
19. TX. Texas Tech University Office of the Ombudsman, (2005). Syllabus Guide for Faculty: Tips for creating a conflict free syllabus. Retrieved June 9, 2005 from http:// www.depts.ttu.edu/ombudsman/publications/SyllabusGuideforFaculty.doc.

ANNEXURE - A: SAMPLE COURSE DESCRIPTOR

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**POWER SYSTEM ANALYSIS**				
Course Code	AEE012				
Programme	B.Tech				
Semester	VI	EEE			
Course Type	Professional Core				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. T. Anil Kumar, Assistant Professor, EEE				
Course Faculty	Mr. T. Anil Kumar, Assistant Professor, EEE				

I. COURSE OVERVIEW:

Power system analysis deals formation impedance and admittance matrices for power system network, finding different electrical parameters for various buses in power system, study fault analysis and represent power system using per unit system, understand steady state and transient stability of power system.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AEE002	II	Electrical Circuits	4
UG	AEE011	V	Transmission And Distribution System	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Power System Analysis	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✘	Seminars	✘	Mini Project	✘	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Assignment And PPTs
PO 2	**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.	3	Assignment And PPTs
PO 3	**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.	3	Assignment And PPTs
PO 5	**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.	2	Assignment And PPTs

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO1	**Problem Solving**: Exploit the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	3	Assignment And PPTs
PSO2	**Professional Skills:** Identify the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	-	-
PSO3	**Modern Tools in Electrical Engineering:** Comprehend the technologies like PLC, PMC, process controllers, transducers and HMI and design, install, test, maintain power systems and industrial applications.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Determine the bus impedance and admittance matrices for power system network..
II	Calculate various parameters at different buses using load flow studies and numerical methods.
III	Discuss the symmetrical component theory, sequence networks, short circuit calculations and per unit representation power system.
IV	Understand the steady state stability of power system and suggest improvements.
V	Analyze the transient stability of power system and check methods to improve the stability.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEE012.01	CLO 1	Define the basic terminology of graph theory to form bus impedance and admittance matrices.	PO1	2
AEE012.02	CLO 2	Determine the bus impedance and admittance matrices for power system.	PO1, PO3	3
AEE012.03	CLO 3	Draw the algorithms to form bus impedance and admittance matrices for configuration of primitive network.	PO1, PO3	3
AEE012.04	CLO 4	Understand necessity of load flow studies and derive static load flow equations.	PO1, PO2	3
AEE012.05	CLO 5	Use different numerical methods to determine unknown parameters at various buses and to draw relevant algorithms.	PO1, PO2, PO5	2
AEE012.06	CLO 6	Compare various numerical methods of load flow studies and analyze DC load flow studies.	PO2	2
AEE012.07	CLO 7	Draw the equivalent reactance network of three phase power system using per unit system.	PO1	2
AEE012.08	CLO 8	Calculate the electrical parameters under symmetrical fault conditions and understand symmetrical component theory.	PO1	3
AEE012.09	CLO 9	Compute the electrical parameters under unsymmetrical faults with and without fault impedance.	PO1, PO2	3
AEE012.10	CLO 10	Discuss the steady state stability, dynamic stability and transient stability of power system.	PO1, PO2	3
AEE012.11	CLO 11	Describe steady state stability power limit, transfer reactance, synchronizing power coefficient, power angle curve.	PO1, PO2, PO3	3
AEE012.12	CLO 12	Determination of steady state stability and methods to improve steady state stability of power system.	PO1, PO2, PO3	2
AEE012.13	CLO 13	Derive the swing equation to study steady state stability of power system.	PO1, PO3	2
AEE012.14	CLO 14	Predict the transient state stability of power system using equal area criteria and solution of swing equation.	PO1, PO2, PO3	2
AEE012.15	CLO 15	Suggest the methods to improve transient stability, discuss application of auto reclosing and fast operating circuit breakers.	PO1, PO2, PO3	2
AEE012.16	CLO 16	Apply the concept of graph theory, numerical methods, symmetrical and unsymmetrical fault to understand steady state and transient analysis.	PO1, PO2, PO3, PO5	2
AEE012.17	CLO 17	Explore the knowledge and skills of employability to succeed in national and international level competitive examinations.	PO1, PO2, PO3, PO5, PO9, PO10, PO12	2

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	2												2		
CLO 2	2		3										2		
CLO 3	2		3										2		
CLO 4	2		3										3		
CLO 5	2	3			2								2		
CLO 6		2											2		
CLO 7	2												2		
CLO 8	3												3		
CLO 9	2	3											3		
CLO 10	2	3											3		
CLO 11	2	3	3										3		
CLO 12	1	2	2										3		
CLO 13	1		2										3		
CLO 14	1	3	3										3		
CLO 15	1	2	2										2		
CLO 16	1	3	3		2								3		
CLO 17	2	2	2		2				3	3		3	2		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES - DIRECT:

CIE Exams	PO 1, PO 2 PO 3, PO 5	SEE Exams	PO1,PO2, PO3,PO5	Assignments	PO 1, PO 2 PO 3, PO 5	Seminars	-
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT:

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS:

Unit-I	POWER SYSTEM NETWORK MATRICES
Graph Theory: Definitions, bus incidence matrix, Y bus formation by direct and singular transformation methods, numerical problems; Formation of Z Bus: Partial network, algorithm for the modification of Z bus matrix for addition of element from a new bus to reference bus, addition of element from a new bus to an old bus, addition of element between an old bus to reference bus and addition of element between two old busses (Derivations and Numerical Problems), modification of Z bus for the changes in network (Numerical Problems).	
Unit-II	**POWER FLOW STUDIES AND LOAD FLOWS**
Load flows studies: Necessity of power flow studies, data for power flow studies, derivation of static load flow equations; Load flow solutions using Gauss Seidel method: Acceleration factor, load flow solution with and without PV buses, algorithm and flowchart; Numerical load flow solution for simple power systems (Max. 3 buses): Determination of bus voltages, injected active and reactive powers (Sample one iteration only) and finding line flows / losses for the given bus voltages; Newton Raphson method in rectangular and polar coordinates form: Load flow solution with or without PV busses derivation of Jacobian elements, algorithm and flowchart, decoupled and fast decoupled methods, comparison of different methods, DC load flow study.	
Unit-III	**SHORT CIRCUIT ANALYSIS PER UNIT SYSTEM OF REPRESENTATION**
Per unit system: Equivalent reactance network of a three phase power system, numerical problems; Symmetrical fault analysis: Short circuit current and MVA calculations, fault levels, application of series reactors, numerical problems; Symmetrical component theory: Symmetrical component transformation, positive, negative and zero sequence components, voltages, currents and impedances. Sequence networks: Positive, negative and zero sequence networks, numerical problems; Unsymmetrical fault analysis: LG, LL, LLG faults with and without fault impedance, numerical problems.	
Unit-IV	**STEADY STATE STABILITY ANALYSIS**
Steady state stability: Elementary concepts of steady state, dynamic and transient stabilities, description of steady state stability power limit, transfer reactance, synchronizing power coefficient, power angle curve and determination of steady state stability and methods to improve steady state stability.	
Unit-V	**TRANSIENT STATE STABILITY ANALYSIS**
Swing equation: Derivation of swing equation, determination of transient stability by equal area criterion, application of equal area criterion, critical clearing angle calculation, solution of swing equation, point by point method, methods to improve stability, application of auto reclosing and fast operating circuit breakers.	
Text Books:	
1. I J Nagrath & D P Kothari, "Modern Power system Analysis", Tata McGraw-Hill Publishing Company, 2nd Edition. 2. M A Pai, "Computer Techniques in Power System Analysis", TMH Publications. 3. B.R.Gupta, " power system analysis and design",S.CHAND publications 4. K Umarao, "Computer techniques and models in power systems", I K International Pvt. Ltd.	
Reference Books:	
1. Stagg , El Abiad, " Computer Methods In Power System". Tata McGraw-Hill.1968. 2. Grainger and Stevenson, "Power System Analysis", Tata McGraw-Hill, 3rd Edition, 2011. 3. J Duncan Glover and M S Sarma., THOMPSON, "Power System Analysis and Design", 3rd Edition 2006. 4. Abhijit Chakrabarthi and Sunita Haldar, "Power system Analysis Operation and control", 3rd Edition, PHI, 2010.	

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No.	Topics to be covered	CLOs	Reference
1	Introduction to graph theory.	CLO1	T4:9.4.1 R1:3.1-3.2
2	Solve numerical problems on graph theory.	CLO1	T4:9.4.1 R1:3.1-3.2
3	Building bus incidence matrix.	CLO2	T4:9.4.3 R1:3.3-3.5
4	Forming Y bus formation by direct method.	CLO2	T4:9.2 R1:3.3-3.5
5,6	Forming Y bus formation by singular transformation. methods,	CLO2	T4:9.2 R1:3.3-3.5
7	Solve numerical problems on bus matrices.	CLO2	T4:9.2 R1:3.3-3.5
8	Formation of ZBUS: Partial network.	CLO3	T4:9.4 R1:4.1
9	Algorithm for the Modification of Z Bus Matrix for addition element from a new bus to reference.	CLO3	T4:9.3&9.5 R1:4.2
10	Algorithm for the Modification of Z Bus Matrix for addition element from a new bus to an old bus.	CLO3	T4: 9.3&9.5 R1:4.3-4.4
11,12	Algorithm for the Modification of Z Bus Matrix for addition element between an old bus to reference Addition of element	CLO3	T4: 9.3&9.5 R1:4.3-4.4
13	Study of necessity of power flow studies – Data for power flow studies – derivation of static load flow equations.	CLO4	T4:9.1 R1:8.1
14	Solution of load flow solutions using Gauss Seidel Method: Acceleration Factor.	CLO5	T4:9.8 R1:8.2
15	Load flow solution with and without P- V buses, Algorithm and Flowchart.	CLO5	T4:9.9.1 R1:9.2
16,17	Find numerical load flow solution for simple power systems (Max. 3- Buses): Determination of bus voltages, injected active	CLO5	T4:9.8 R1:9.2
18,19	Discuss on newton raphson method in rectangular form: load flow, solution with or without PV busses- Derivation of jacobian	CLO5	T4:9.10 R1:9.2
20	Discussion newton raphson method in polar co- ordinates form: load flow solution with or without pv busses-Derivation of	CLO5	T4:9.11.2 R1:9.2
21,22	Study on decoupled and fast decoupled methods for load flow solution.	CLO5	T4:9.12 R1:9.2
23	Comparison of Different Methods – DC load Flow.	CLO6	T4:9.4.12 R1:9.2
24,25	Short Circuit Analysis: Short Circuit Current and MVA Calculations.	CLO7	T4:10.3 R1:6.1-6.3
26	Understand fault levels.	CLO7	T4:10.4 R1:6.1-6.3
27	Application of series reactors.	CLO7	T4:10.4 R1:6.1-6.3
28	Solving numerical problems (Symmetrical fault Analysis).	CLO8	T4:10.4 R1:6.4
29	Understand symmetrical component transformation, positive, negative and zero sequence components.	CLO8	T4:10.5 R1:
30	Draw sequence networks.	CLO8	T4:10.6 R1:6.3
31	Derive sequence voltages, currents and impedances.	CLO08	T4:10.7 R1:6.3
32	Solving numerical problems on symmetrical components.	CLO8	T4:10.5 R1:6.3
33,34	Understand LG fault with and without fault impedance and numerical problems.	CLO9	T4:10.13 R1:6.3

Lecture No.	Topics to be covered	CLOs	Reference
35,36	Study fault with and without fault impedance and numerical problems.	CLO9	T4:10.13 R1:6.1-6.3
37,38	Determine LLG fault with and without fault impedance and numerical problems.	CLO09	T4:10.16 R1:6.1-6.3
39	Compare LG, LL, LLG faults with and without fault impedance and numerical problems.	CLO9	T4:10.17 R1:6.1-6.3
40,41	Introduction to steadystate, dynamic and transient stabilities.	CLO10	T4:13.1 R1:10.1
42,44	Description of steady state stability power limit, transfer reactance, synchronizing power coefficient.	CLO11	T4:13.2 R1:10.3
45,46	Plot Power Angle Curve and determination of steady state,. stability.	CLO11	T4:13.2 R1:
47,48	Explain methods to improve steady state stability.	CLO12	T4:13.2 R1:10.3
49	Derivation of swing equation.	CLO13	T4:13.3 R1:10.2
50,51	Determination of transient stability by equal area criterion.	CLO14	T4:13.6 R1:10.5
52	Application of equal area criterion to different cases.	CLO14	T4:13.7 R1:10.5
53	Discuss importance of critical clearing angle calculation.	CLO14	T4:13.6 R1:10.5
54,55	Solving numerical problems on equal area criteria.	CLO14	T4:13.7 R1:10.5
56	Solution of swing equation: point-by- point method.	CLO14	T4:13.8 R1:10.5
57	Explain methods to improve stability.	CLO15	T4:13.11 R1:10.6
58	Application of auto reclosing and fast operating circuit breakers.	CLO15	T4:13.11 R1:10.7

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S. No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Formation of bus impedance and admittance matrices using digital methods.	MATLAB Software	PO1, PO5	-
2	Power flow studies in integrated system.	Introduction To Distribution Generation	PO1, PO3	PSO1

Prepared by:
Mr. T. Anil Kumar, Assistant Professor

HOD, EEE