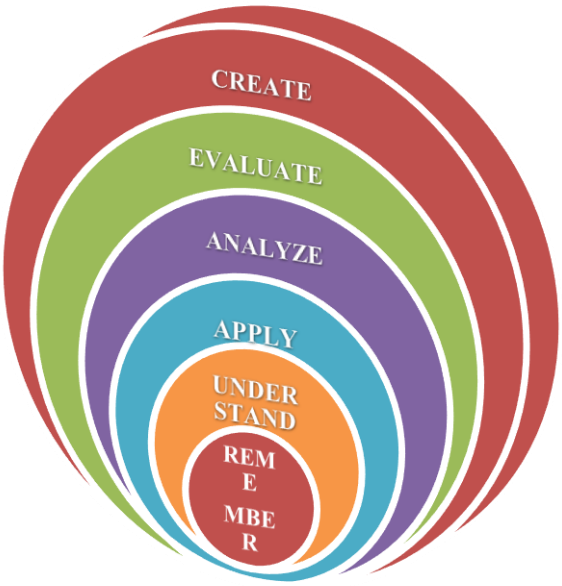
OUTCOME BASED EDUCATION BOOKLET

INFORMATION TECHNOLOGY

B.Tech

For the Batch of Students admitted during

Academic Year 2018-19



.....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-500043

Vision

The Department envisions to become a Center of Excellence in Information Technology with a strong teaching and research environment that produces competent graduates and to inculcate traits to make them not only good professionals but also kind, committed and socially oriented human beings.

Mission

To promote a teaching and learning process that includes latest advancements in information technology, that provides strong practical base for the graduates to make them excellent human capital for sustainable competitive edge and social relevance by inculcating the philosophy of continuous learning and innovation in the core areas.

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 DAC Information Technology department on 3/9/2014):

Information Technology Departmental Advisory Council: The Information Technology Department Advisory Council (ITDAC) includes a diverse group of experts from academe and industry, as well as alumni representation. The Advisory Board meets annually, or as needed, for a comprehensive review of the Information Technology Department strategic planning and programs.

The Advisory Council meets with administration, faculty and students and prepares a report, which is presented to principal. In each visit, the Department of Information Technology responds to the report indicating improvements and amendments to the program.

1. PROGRAM EDUCATIONAL OBJECTIVES, OUTCOMES AND ASSESSMENT CRITERIA

Learning Outcomes, Assessment Criteria

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

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

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

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

2. B. TECH –INFORMATION TECHNOLOGY PROGRAM EDUCATIONAL OBJECTIVES

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

PROGRAM EDUCATIONAL OBJECTIVES:

PEO1. Excellence in Career

To prepare the graduates for a successful career to meet the diversified needs of industry, academia and research.

PEO2. Professional Effectiveness and Contribution to Society

To train students to comprehend, analyze, design and provide ability to create novel products and technologies that give solution-frameworks to real world problems.

PEO3. Problem Solving

To equip graduates with a solid foundation in discrete mathematical and engineering fundamentals required to develop problem solving ability in complex engineering design.

PEO4. Exercising Leadership

To inculcate in graduates the qualities of leadership in technology innovation and entrepreneurship with effective communication skills, teamwork, ethics and to create ability for life-long learning needed in a successful professional career.

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

i. To prepare the graduates for a successful career to meet the diversified needs of industry,

academia and research.

- Significantly contributing to delivery of desired component, product, or process
- Formulating and solving moderately complex computer engineering problems, accounting for hardware/software/human interactions
- Skillfully using state-of-the-art tools for computer engineering processes
- Making practical recommendations that address computer engineering product and system level issues
- Producing clear written computer engineering documentation (papers, reports, and significant parts of proposals)
- Being asked to make presentations or reports for internal colleagues or clients

- Applying for a patent or making a useful invention or innovation
- Participating in the field through public speaking, activity in professional societies, technical associations, standards boards, etc.
- Properly handling a situation involving intellectual property rights
- Accounting for larger societal, ethical, legal, business, and technical context while making decisions on a project
- Leading a project or design team Election or appointment to leadership position in a professional society

ii. To train students to comprehend, analyze, design and provide ability to create novel products and technologies that give solution-frameworks to real world problems

- Estimating correctly the required resources (time, team, equipment, etc.) for computer engineering projects
- Making appropriate decisions on when to outsource, when to use off-the-shelf components, and when to develop components in-house
- Seeking assistance or elevating problems whenever and wherever necessary

iii. To equip graduates with a solid foundation in discrete mathematical and engineering fundamentals required to develop problem solving ability in complex engineering design

- Accepting and satisfactorily progressing in the graduate degree program
- Successfully completing a course for B.Tech
- Successfully completing a tutorial at a conference
- Learning a new skill, tool, area, or system on your own
- Reading technical books, journals, conference papers, technical reports, or standards
- Attending a technical conference, symposium, or workshop
- Publishing papers in conferences or referred journals, or producing an internally reviewed publication
- Belonging to a professional society to excel in chosen area

iv. To inculcate in graduates the qualities of leadership in technology innovation and entrepreneurship with effective communication skills, teamwork, ethics and to create ability for life-long learning needed in a successful professional career.

- Appropriately using tools for collaborations, in the areas of telecommunication, video communication, distributed meeting systems, etc.
- Intelligently using tools for project and configuration management, e.g., resource planning systems, concurrent versions system, etc.
- Working successfully on ethnically, technically or diverse teams
- Effectively resolving problems encountered in team work
- Effective Communication in a group environment
- Designate persuasively
- Properly handling a situation involving ethics (being professional, be ethical)

3. B. TECH –INFORMATION TECHNOLOGY PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

A graduate of the Information Technology Program Outcomes will demonstrate:

PROGRAM OUTCOMES:

PO1. Engineering Knowledge

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

PO2. Problem Analysis

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

PO3. Design/Development of Solutions

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

PO4. Conduct Investigations of Complex Problems

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

PO5. Modern Tool Usage

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

PO6. The Engineer and Society

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

PO7. Environment and Sustainability

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

PO8. Ethics

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

PO9. Individual and Team Work

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

PO10. Communication

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

PO11. Life-long Learning

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

PO12. Project Management and Finance

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

PROGRAM SPECIFIC OUTCOMES

PSO1. Professional Skills

The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity

PSO2. Software Engineering practices

The ability to apply standard practices and strategies in software service management using open ended programming environments with agility to deliver a quality service for business success.

PSO3. Successful career and Entrepreneurship

The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.

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

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

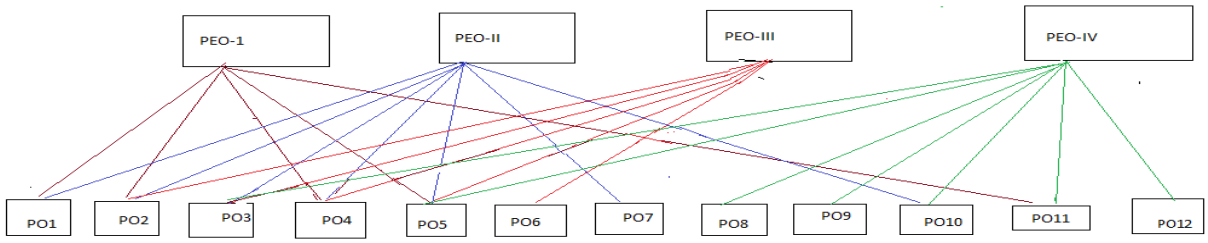


Figure: *Correlation between the PEOs and the POs and PSOs*

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

	Program Educational Objectives		Program Outcomes& Program Specific Outcomes
I	To prepare the graduates for a successful career to meet the diversified needs of industry, academia 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
		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
		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.
		PSO1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.
		PSO3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.
II	To equip graduates with a solid foundation in discrete mathematical and engineering fundamentals required to develop problem solving ability in complex engineering design.	**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
		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
		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.
		PSO1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.
III	To train students to comprehend, analyze, design and provide ability to create novel products and technologies that give solution-frameworks to real world 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
		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.
		PSO2	**Software Engineering practices:** The ability to apply standard practices and strategies in software service management using open-ended programming environments with agility to deliver a quality service for business success.
IV	To inculcate in graduates the qualities of leadership in technology innovation and entrepreneurship with effective communication skills, teamwork, ethics and to create ability for life-long learning needed in a successful professional career.	**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
		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 a.nd management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environment.
		PSO3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.

RELATION BETWEEN THE PROGRAM OUTCOMES AND PROGRAM EDUCATIONAL OBJECTIVES

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

POs ↓ / PEOs →		(1) Excellence in Career	(2) Professional Effectiveness	(3) Problem Solving	(4) Exercising Leadership
PO1	Engineering Knowledge			3	
PO2	Problem Analysis			3	
PO3	Design/Development of Solutions		3		2
PO4	Conduct Investigations of Complex Problems	3			3
PO5	Modern Tool Usage		2	2	
PO6	The Engineer and Society		3		2
PO7	Environment and Sustainability		3		3
PO8	Ethics		3		
PO9	Individual and Team work	2		3	
PO10	Communication		3		
PO11	Life-long Learning	1		2	
PO12	Project Management and Finance				2

Relationship between Program Outcomes and Program Educational Objectives
Key: 3 = High; 2 = Medium; 1 = Low

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

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

PSOs ↓ / PEOs →		(1) Excellence in Career	(2) Professional Effectiveness	(3) Problem Solving	(4) Exercising Leadership
PSO1	Professional Skills		3		2
PSO2	Problem-solving skills	3		3	2
PSO3	Successful career and Entrepreneurship	2	3	2	

Relationship between Program Specific Outcomes and Program Educational Objectives
Key: 3 = High; 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) IT GRADUATES

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

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

Each Information Technology student will demonstrate the following attributes by the time they graduate:

PO1. Engineering Knowledge

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 study of their own engineering discipline.

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, combining theory and experience, and use of other relevant knowledge and skills. This can include:
- Knowledge of characteristics of particular materials, equipment, processes, or products;
- Workshop and laboratory skills;
- Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.);
- Understanding use of technical literature and other information sources 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 the 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 of and ability to apply a systems approach to engineering problems.

PO2. 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, processor system to meet a defined need. It involves significant technical and intellectual challenges and can be used to integrate all engineering understanding, knowledge and skills to the solution of real problems. Graduates will therefore need the knowledge, understanding and skills to:

- Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues;
- Understand customer and user needs and the importance of considerations such as aesthetics;

- Identify and manage cost drivers;
- Use creativity to establish innovative solutions;
- Ensure fitness for 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 risk (including environmental risk) issues.

PO3. 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

- Independence
- 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 textbook for reference.
- Teamwork is important not only for helping the students 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.
- Subjective evidence from senior students shows that the friendships and teamwork extends into the junior years, and for some of those students, the friendships continue into the workplace after graduation.
- Ability to work with all levels of people in an organization
- Ability to get along with others
- Demonstrated ability to work well with a team

PO4. 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

Is based on the problem solving process that has been well documented in engineering texts. The elements of the process include:

- Problem or opportunity identification
- Problem statement and system definition
- Problem formulation and abstraction
- Information and data collection
- Model translation
- Validation
- Experimental design
- Solution development or experimentation
- Interpretation of results
- Implementation and documentation

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

PO5. 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

- Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior.
- Stood up for what they believed in.
- High degree of trust and integrity.

PO6. 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

- Clarity
- Grammar/Punctuation
- References

Verbal Communication: "Students should demonstrate the ability to communicate effectively orally."

- Speaking Style
- Subject Matter

PO7. Ethics

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

Performance Criteria Definitions

- 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 risk (including environmental risk) issues;
- Understanding of the need for a high level of professional and ethical conduct in engineering.

PO8. 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

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

- Project management professional certification
- MBA
- Begin work on advanced degree

- Keeping current in CSE and advanced engineering concepts
- Personal continuing education efforts
- Ongoing learning – stays up with industry trends/ new technology
- Continued personal development
- Have learned at least 2-3 new significant skills
- Have taken up to 80 hours (2 wks) training per year

PO9. Communication

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

Performance Criteria Definitions

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

PO10. 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

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

PO11. 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

- Designing and development of software programs, modifying existing computer software, testing of software systems, performing the related documentation work and consulting with other engineering professionals to assess the interface between the hardware and software.
- Closely work with other information technology professionals including programmers, engineers and system analysts to ensure that the software design is feasible and analyze the specific requirements of users.
- Apart from developing new software programs, also work on exiting software programs to check for errors and eliminate them for improved performance.
- Consult with consumers/customers to comprehend the design requirements.
- Use a variety of scientific and mathematical techniques to predict the outcome of software designs.

PROGRAM SPECIFIC OUTCOMES OF (B.Tech) IT GRADUATES

PSO1. Professional Skills

The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.

- Focused in programming milieu by achieving certifications.
- Practicing the way of communicating to others in a persuasive means.
- Behavioral cram of the adjoining societal to accomplish the aspiration.

PSO2. Software Engineering practices

The ability to apply standard practices and strategies in software service management using open ended programming environments with agility to deliver a quality service for business success.

- Implement the programs by preparing the algorithms or pseudo code from the requirement of the client.
- Integrate the different components to suit the requirements and client satisfaction.

PSO3. Successful Career and Entrepreneurship:

The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies

- Comprehend the inevitability of the world where we are sheathing.
- Novelty starts from the stipulation and imagination of creature leads to entrepreneur.

Courses offered in Information Technology Curriculum (JNTUH-R18) –Vs- Program Outcomes and Program Specific Outcomes Attained through course modules for I-I, I-II Semesters

I SEMESTER															
Code	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
AHSB02	Linear Algebra and Calculus	✔	✔											✔		
AHSB03	Engineering Chemistry	✔	✔					✔						✔		
AEEB01	Fundamentals of Electrical Engineering	✔	✔	✔			✔								✔	
AHSB09	Engineering Chemistry Laboratory	✔	✔					✔						✔		
AEEB05	Fundamentals of Electrical Engineering Laboratory	✔	✔	✔			✔								✔	
AMEB01	Workshop / Manufacturing Practices Laboratory								✔	✔	✔	✔	✔	✔		
II SEMESTER																
Code	**Subject**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
AHSB01	English									✔	✔	✔				✔
AHSB12	Probability and Statistics	✔	✔		✔									✔		
AHSB13	Semiconductor Physics	✔	✔			✔								✔		
ACSB01	Programming for Problem Solving	✔	✔	✔		✔							✔	✔	✔	✔
AHSB08	English Language and Communication Skills Laboratory									✔	✔	✔				✔
AHSB10	Engineering Physics Laboratory	✔	✔			✔								✔		
ACSB02	Programming for Problem Solving Laboratory	✔	✔	✔		✔							✔	✔	✔	✔

AMEB02	Engineering Graphics and Design Laboratory	✔	✔	✔	✔	✔								✔	✔	

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

The categorization of outcomes of the above Information Technology courses is grouped as follows: The Courses covered by Individual Program Outcomes and Program Specific Outcomes

PO1: Engineering Knowledge

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

AHSB02	Linear Algebra and Calculus	AHSB13	Semiconductor Physics
AHSB03	Engineering Chemistry	ACSB01	Programming for Problem Solving
AEEB01	Fundamentals of Electrical Engineering	AHSB10	Engineering Physics Laboratory
AHSB09	Engineering Chemistry Laboratory	ACSB02	Programming for Problem Solving Laboratory
AEEB05	Fundamentals of Electrical Engineering Laboratory	AMEB02	Engineering Graphics and Design Laboratory
AHSB12	Probability and Statistics		

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

AHSB02	Linear Algebra and Calculus	AHSB13	Semiconductor Physics
AHSB03	Engineering Chemistry	ACSB01	Programming for Problem Solving
AEEB01	Fundamentals of Electrical Engineering	AHSB10	Engineering Physics Laboratory
AHSB09	Engineering Chemistry Laboratory	ACSB02	Programming for Problem Solving Laboratory
AEEB05	Fundamentals of Electrical Engineering Laboratory	AMEB02	Engineering Graphics and Design Laboratory
AHSB12	Probability and Statistics		

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

AEEB01	Fundamentals of Electrical Engineering	ACSB02	Programming for Problem Solving Laboratory
AEEB05	Fundamentals of Electrical Engineering Laboratory	AMEB02	Engineering Graphics and Design Laboratory
ACSB01	Programming for Problem Solving		

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

AHSB12	Probability and Statistics	AMEB02	Engineering Graphics and Design Laboratory

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

AHSB13	Semiconductor Physics	AHSB10	Engineering Physics Laboratory
ACSB01	Programming for Problem Solving	ACSB02	Programming for Problem Solving Laboratory

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

AEEB01	Fundamentals of Electrical Engineering	AEEB05	Fundamentals of Electrical Engineering Laboratory

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

AHSB03	Engineering Chemistry	AHSB09	Engineering Chemistry Laboratory

PO8: Ethics

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

AMEB01	Workshop / Manufacturing Practices Laboratory		

PO9: Individual and Team Work

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

AMEB01	Workshop / Manufacturing Practices Laboratory	AHSB08	English Language and Communication Skills Laboratory
AHSB01	English		

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

AMEB01	Workshop / Manufacturing Practices Laboratory	AHSB08	English Language and Communication Skills Laboratory
AHSB01	English		

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

AMEB01	Workshop / Manufacturing Practices Laboratory	AHSB08	English Language and Communication Skills Laboratory
AHSB01	English		

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

AMEB01	Workshop / Manufacturing Practices Laboratory	ACSB02	Programming for Problem Solving Laboratory
ACSB01	Programming for Problem Solving		

PSO1: Professional Skills

The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.

AHSB02	Linear Algebra and Calculus	AHSB13	Semiconductor Physics
AHSB03	Engineering Chemistry	ACSB01	Programming for Problem Solving
AHSB09	Engineering Chemistry Laboratory	AHSB10	Engineering Physics Laboratory
AMEB01	Workshop / Manufacturing Practices Laboratory	ACSB02	Programming for Problem Solving Laboratory
AHSB12	Probability and Statistics	AMEB02	Engineering Graphics and Design Laboratory

PSO2: Software Engineering Practices

The ability to apply standard practices and strategies in software service management using open ended programming environments with agility to deliver a quality service for business success.

AEEB01	Fundamentals of Electrical Engineering	ACSB02	Programming for Problem Solving Laboratory
AEEB05	Fundamentals of Electrical Engineering Laboratory	AMEB02	Engineering Graphics and Design Laboratory
ACSB01	Programming for Problem Solving		

PSO3: Successful Career and Entrepreneurship:

The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies

AHSB01	English	ACSB01	Programming for Problem Solving
AHSB08	English Language and Communication Skills Laboratory	ACSB02	Programming for Problem Solving Laboratory

8. METHODSOFMEASURINGLEARNINGOUTCOMESANDVALUEADDITION

Therearemanydifferentwaystoassessstudentlearning.Inthissection,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 courser views 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 courser views 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 sub sequent 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 test s comprising of short answer questions, quiz based discussions, multiple-choice, true-false, and matching tests are conducted to strengthen the teaching-learning process. Apart from teacher control and covering content, the teacher also acts as a felicitator and students discover things for themselves, enabling them to be more independent and becoming life-long learners exploring student-centric educational philosophy.

iv. Course Objective Surveys

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

v. Course Instructor's Evaluations

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

vi. Graduating Senior's Survey

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

vii. Alumni Survey

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

viii. Employer Survey

The main purpose of this employer questionnaire is to know employer's views about the skills they require of employees compared to the skills actually possessed by them. The purpose is also to identify gaps in technical and vocational skills, need for required

training practices to fill these gaps and criteria for hiring new employees. These employer surveys are reviewed by the College Academic Council (CAC) to affect the present curriculum to suit the requirements of the employer.

ix. Laboratory and Project Works

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

x. Balanced Composition in Curriculum

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

xi. Department Academic Committee and Faculty Meetings

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

xii. Professional Societies

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

Part - II

METHODOLOGY FOR PREPARATION AND ASSESSMENT OF COURSE LEVEL STUDENT LEARNING OUTCOMES

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

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

Expected Learning Outcomes:

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

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

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

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

Classroom Assessment Technique (CAT):

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

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

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

Expected learning outcome:

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

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

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

1. COURSE PURPOSE

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

The course purpose involves the following:

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

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

2. EXPECTED LEARNING OUTCOMES

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

Simply stated, expected learning outcome statements describe:

- What faculty members want students to know at the end of the course and
- What faculty members want students to be able to do at the end of the course

Learning outcomes have three major characteristics

- They specify an action by the students/learners that is **observable**
- They specify an action by the students/learners that is **measurable**
- They specify an action that is done by the **students/learners** (rather than the faculty members)

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

3. TO DEFINE EFFECTIVE LEARNING OUTCOME STATEMENTS

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

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

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

For example, please look at the following learning outcomes statements:

- The students will understand basic Electronic components.

- The students will appreciate knowledge discovery from Communication techniques.

Both of these learning outcomes are stated in a manner that will make them difficult to assess. Consider the following:

- How do you observe someone "understanding" a theory or "appreciating" Data Mining techniques?

- How easy will it be to measure "understanding" or "appreciation"?

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

- The students will be able to identify and describe what techniques are used to extract knowledge from Communication techniques.

- The students will be able to identify the characteristics of Classification techniques from other Digital Communication techniques.

Incorporating Critical Thinking Skills into Expected Learning Outcomes Statements

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

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

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

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

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

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

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

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

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

List of Action Words Related to Critical Thinking Skills

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

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

				Prove Rate Recommend Rule on Select Support Value	Predict Propose Solution Solve Suppose Test Theory

4. TIPS FOR DEVELOPING COURSE LEVEL EXPECTED LEARNING OUTCOMES STATEMENTS

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

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

5. SAMPLE EXPECTED LEARNING OUTCOMES STATEMENTS

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

Operating Systems:

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

- **Apply** different techniques for the improvement of system performance.
- **Identify**the synchronous and asynchronous communication mechanisms in their respective Operating System.
- **Compare** performance of process scheduling algorithms.
- **Identify** the techniques for minimization of turnaround time, waiting time & response time and also maximization of throughput with keeping CPU as busy as possible.
- **Build** algorithmic solutions to process synchronization problems.

- **Utilize** modern operating system calls such as Linux process and synchronization libraries.
- **Explain** the value and dangers of in-memory caching of file system disk blocks and to describe the algorithms for checking block and file consistency
- **Explain** how memory is allocated among multiple resources.
- **Understand** and **Analyze** theory and implementation of: processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and files AND deadlocks.
- **Explain** the principles of OS security, basic types of attacks, and common countermeasures
- **Compare** different Operating Systems.

Software Engineering**:**
Students who complete this course should be able to:

- **Analyze** the importance of software Myths.
- **Illustrates** the categories of different software applications.
- **Understands** the basic concepts of software development.
- **Recall** the importance of CMMI.
- **Compare** different process models.
- **Classify** various requirements for the project.
- **State** the importance of SRS document.
- **Organize** various system models.
- **Compare** different design concepts.
- **State** the importance of different Architectural styles and Patterns.
- **Understand** importance of golden rules for performing user interface design.
- **State** the importance of process and product metrics.
- **Illustrate** various testing techniques.
- **Elaborate** on Quality management.
- **Construct** RMMM Plan.
- **Elaborate** on Risk management.

6. AN OVERVIEW OF ASSESSMENT

What is assessment?
According to Palomba and Banta (1999) assessment involves the systematic collection, review, and use of evidence or information related to student learning. Assessment helps faculty understand how well their students understand course topics/lessons. Assessment exercises are often anonymous. This anonymity allows students to respond freely, rather than trying to get the "right" answer or look good.

Assessment exercises attempt to gauge students' understanding in order to see what areas need to be re-addressed in order to increase the students' learning.

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

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

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

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

What is involved in the assessment process?

1. Establishing expected learning outcomes for the course;

2. Systematically gathering, analyzing, and interpreting evidence (through formal assessment activities such as exams or papers and informal assessment activities such as in-class discussions exercises) to determine how well the students' learning matches:

    - Faculty expectations for what students will learn and

    - The stated expected learning outcomes for the course

3. Faculty members should use this evidence/assessment of student learning to:

    - Provide 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

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

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

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

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

How advanced is this course?

- Is this course an undergraduate or graduate course?
- Where does this course fall in students' degree plan - as an introductory course or an advanced course?

- Can I expect the students taking this course to know anything about the course topic?
- Are other faculty members counting on students who have taken this course to have mastered certain knowledge or skills?

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

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

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

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

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

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

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

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

The "Course Description" contains the following contents:

- Course Overview
- Prerequisite(s)

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

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 Fromhttp://www.viterbo.edu/academic/titleiii/events/files/Jun04/Intended%20Learning%20Outcomes.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/bloom1.html .

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 (As per NBA Norms post June, 2015)

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

INFORMATION TECHNOLOGY

COURSE DESCRIPTOR

Course Title	**THEORY OF COMPUTATION**				
Course Code	AIT002				
Programme	B.Tech				
Semester	IV	CSE | IT			
Course Type	Foundation				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Dr. K Srinivasa Reddy, Professor and HOD, IT				
Course Faculty	Mr. Ch Suresh Kumar Raju, Assistant Professor, CSE				

I. COURSE OVERVIEW:

Introduction to the theory of computation, including models of computation such as Turing machines; theory of programming languages, including grammars, parsing, syntax and semantics. This course in reached to student by power point presentations, lecture notes, and assignment questions ,previous model question papers, multiple choice questions and question bank of long and short answers.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	ACS002	II	Data Structures	4
UG	AHS013	III	Discrete Mathematical Structures	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
THEORY OF COMPUTATION	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.	3	Assignments
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	Lectures, Assignments
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.	2	Assignments
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.	2	Guest Lettuces
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	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.	2	Lectures, Assignments
PSO 2	**Software Engineering Practices:** The ability to apply standard practices and strategies in software service	2	Assignments

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
	management using open-ended programming environments with agility to deliver a quality service for business success		
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.	1	Guest Lectures

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Comprehend abstract, mathematical models of computation and use them to solve computational problems.
II	Interpret the relationship between formal languages in Chomsky's hierarchy and different Machines.
III	Analyze and explain the behavior of push-down automata.
IV	Understand the limits and capacities of Turing's machines to recognize languages.

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
AIT002.01	CLO 1	Use the definitions and notations for sets, relations and functions in defining and study Finite Automata	PO1; PO2	3
AIT002.02	CLO 2	Knowledge on formal languages and Kleene's Theorem to intend programming languages	PO1; PO2; PO3	2
AIT002.03	CLO 3	Construct deterministic and nondeterministic finite state automata (DFA and NFA) for solving simple decision problems.	PO1; PO2; PO4; PO5	2
AIT002.04	CLO 4	Perform conversions between nondeterministic finite automata and deterministic finite automata and regular expressions and finite state automata to gain knowledge about formal proofs in computer science	PO1; PO2; PO3; PO4	2
AIT002.05	CLO 5	Knowledge on recursive definitions of regular languages, regular expressions and the use of regular expressions to represent regular languages	PO1; PO2; PO3; PO4	2
AIT002.06	CLO 6	Detailed knowledge on the relationship between regular expressions and finite automata	PO2; PO3	2
AIT002.07	CLO 7	Identify that few languages are not regular by using Pumping lemma	PO4	2
AIT002.08	CLO 8	Knowledge on Left Linear grammar, Right Linear grammars and converting grammars into Finite Automata.	PO1; PO2; PO5	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AIT002.09	CLO 9	Understand the fundamental role played by Context-Free Grammars (CFG) in designing formal computer languages with simple examples	PO2; PO3	2
AIT002.10	CLO 10	Knowledge on Context-Free Grammars so that able to prove properties of Context-Free Grammars.	PO2	3
AIT002.11	CLO 11	Identify relationship between regular languages and context-free grammars	PO1; PO2; PO3	2
AIT002.12	CLO 12	Use the pumping lemma for Context Free Languages to show that a language is not context-free	PO2; PO4	2
AIT002.13	CLO 13	Understand the equivalence between Context-Free Grammars and Non-deterministic Pushdown Automata	PO1; PO2; PO3	2
AIT002.14	CLO 14	Understand deterministic Pushdown Automata to parse formal language strings by using (i) top down or (ii) bottom up techniques	PO2; PO4; PO5	2
AIT002.15	CLO 15	Knowledge on converting Context-Free Grammars into pushdown automata to identify the acceptance of a string by the Context Free Language	PO1; PO2	3
AIT002.16	CLO 16	Understand the path processing computation using Turing Machines (Deterministic and Non-Deterministic) and Church-Turing Thesis in computers.	PO1; PO2; PO4; PO5	1
AIT002.17	CLO 17	Knowledge on non-halting Turing Machine accepted by Recursively Enumerable Languages	PO1; PO4	1
AIT002.18	CLO 18	Understand the power of the Turing Machine, as an abstract automaton, that describes computation, effectively and efficiently	PO1; PO4	1
AIT002.19	CLO 19	Theory of Computation is important in programming language design, parsers, web-scrappers, Natural Language Processing (NLP), and is at the heart of modern compiler architectures.	PO1; PO2; PO5	3
AIT002.20	CLO 20	Process the knowledge and skills for employability and to succeed in national and international level competitive exams.	PO5	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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	3	2												2	
CLO 2	3	3	2											2	
CLO 3	3	3		2	2								2		
CLO 4	3	2	3	2										3	
CLO 5	2	3	2	2										3	
CLO 6		3	2										2		
CLO 7				3									2		
CLO 8	2	3			2									2	
CLO 9		2	3											2	
CLO 10		3												2	
CLO 11	2	3	2										2	2	1
CLO 12		3		3									2	2	
CLO 13	3	2	2										2	2	
CLO 14		3		2	2									3	
CLO 15	2	3											2	2	
CLO 16	3	3		2	2									3	
CLO 17	3			2										1	
CLO 18	3			2									2	3	
CLO 19	3	2			2									3	
CLO 20					1								2		1

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1; PO2; PO3;PO4; PO5	SEE Exams	PO1;PO2; PO3;PO4; PO5	Assignments	PO1;PO2; PO3;PO4; PO5	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	**FINITE AUTOMATA**
Fundamentals: Alphabet, strings, language, operations; Introduction to finite automata: The central concepts of automata theory, deterministic finite automata, nondeterministic finite automata, an application of finite automata, finite automata with epsilon transitions.	
Unit-II	**REGULAR LANGUAGES**
Regular sets, regular expressions, identity rules, constructing finite automata for a given regular expressions, conversion of finite automata to regular expressions, pumping lemma of regular sets, closure properties of regular sets (proofs not required), regular grammars-right linear and left linear grammars, equivalence between regular linear grammar and finite automata, inter conversion.	
Unit-III	**CONTEXT FREE GRAMMARS**
Context free grammars and languages: Context free grammar, derivation trees, sentential forms, right most and leftmost derivation of strings, applications. Ambiguity in context free grammars, minimization of context free grammars, Chomsky normal form, Greibach normal form, pumping lemma for context free languages, enumeration of properties of context free language (proofs omitted).	
Unit-IV	**PUSHDOWN AUTOMATA**
Pushdown automata, definition, model, acceptance of context free language, acceptance by final state and acceptance by empty stack and its equivalence, equivalence of context free language and pushdown automata, inter conversion;(Proofs not required);Introduction to deterministic context free languages and deterministic pushdown automata.	
Unit-V	**TURING MACHINE**
Turing machine: Turing machine, definition, model, design of Turing machine, computable functions, recursively enumerable languages, Church's hypothesis, counter machine, types of Turing machines (proofs not required), linear bounded automata and context sensitive language, Chomsky hierarchy of languages.	
Text Books:	
John E. Hopcroft, Rajeev Motwani, Jeffrey D.Ullman, ―Introduction to Automata, Theory, Languages and Computation‖, Pearson Education, 3rd Edition, 2007.	
Reference Books:	

1. John C Martin, ―Introduction to Languages and Automata Theory, Tata McGraw-Hill, 3rd Edition, 2007.
2. Daniel I.A. Cohen, ―Introduction to Computer Theory, John Wiley & Sons, 2nd Edition, 2004.

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Alphabet, strings, language, operations	CLO 1	T1: 1.5-1.6
2	Introduction to finite automata: The central concepts of automata theory	CLO 1	T1: 2.1-2.2
3	Deterministic finite automata	CLO 3	T1: 2.2-2.3
4-5	Nondeterministic finite automata	CLO 3	T1: 2.3-2.4
6	An application of finite automata	CLO 4	T1: 2.4-2.5
7	Finite automata with epsilon transitions	CLO 2	T1: 2.5-2.6
8-9	Finite Automata with output: Moore and Melay Machines	CLO 3	R2: Chapter 9
10	Regular sets, regular expressions, identity rules	CLO 5	T1: 3.1-3.2
11	Constructing finite automata for a given regular expressions	CLO 5	T1: 3.1-3.2
12-13	Conversion of finite automata to regular expressions	CLO 5	T1: 3.1-3.2
14	Pumping lemma of regular sets	CLO 5	T1: 4.1-4.2
15	Closure properties of regular sets (proofs not required)	CLO 6	T1: 4.1-4.2
16-17	Regular grammars-right linear and left linear grammars	CLO 7	T1: 4.4-4.5
18	Equivalence between regular linear grammar and finite automata, inter conversion.	CLO 7	T1: 4.4-4.5
19	Context free grammar	CLO 8	T1: 5.1-5.2
20-22	derivation trees, sentential forms, right most and leftmost derivation of strings	CLO 9	T1: 5.1-5.2
23	Ambiguity in context free grammars	CLO 10	T1: 5.4-5.5
24-25	Minimization of context free grammars	CLO 11	T1: 7.4-7.5
26-27	Chomsky normal form, Greibach normal form	CLO 12	T1: 7.4-7.5
28-29	Pumping lemma for context free languages, properties	CLO 13	T1: 7.2-7.3
30	Pushdown automata, definition, model	CLO 14	T1: 6.1-6.2
31-33	Acceptance by final state and acceptance by empty stack and its equivalence	CLO 14	T1: 6.2
34-35	Equivalence of context free language and pushdown automata, inter conversion.	CLO 15	T1: 6.3
36	Deterministic context free languages and deterministic push down automata	CLO 16	T1: 6.4
37-38	Turing machine: Turing machine, definition, model	CLO 17	T1: 8.1-8.2
39-40	Design of Turing machine, computable functions,	CLO 18	T1: 8.1-8.2
41-43	Recursively enumerable languages, Types of Turing machines and Church's hypothesis.	CLO 19	T1: 8.2-8.6
44-45	Linear bounded automata and context sensitive language, Chomsky hierarchy of languages.	CLO 20	R2: Chapter 30

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

S NO	Description	Proposed Actions	Relevance With POs	Relevance With PSOs
1	Finite automata with output	Seminars / Guest Lectures / NPTEL	PO 1, PO 2, PO 3	PSO 1, PSO 2
2	Deterministic Pushdown Automata	Seminars / Guest Lectures / NPTEL	PO 2, PO 3	PSO 1
3	JFLAP Automation Tool	Assignments / Laboratory Practices	PO 1, PO 3, PO 4	PSO 2

Prepared by: Dr. K Srinivasa Reddy, Professor and HOD, IT

HOD, IT