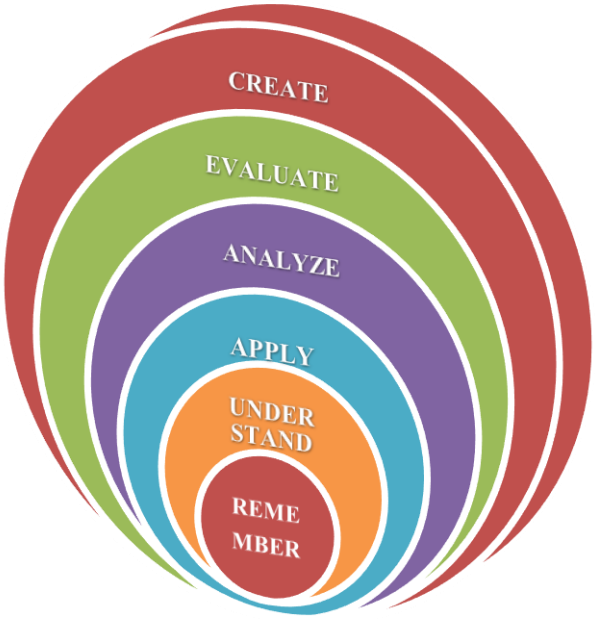
OUTCOME BASED EDUCATION BOOKLET

COMPUTER SCIENCE ENGINEERING

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 - 500 043

Vision

The Vision of the department is to produce competent graduates suitable for industries and organizations at global level including research and development with Social responsibility.

Mission

To provide an open environment to foster professional and personal growth with a strong theoretical and practical background having an emphasis on hardware and software development making the graduates industry ready with social ethics.

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 CSE on 3/9/2014):

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

1. PROGRAM EDUCATIONAL OBJECTIVES, OUTCOMES AND ASSESSMENT CRITERIA

Learning Outcomes, Assessment Criteria

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

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

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

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

2. B. TECH – COMPUTER SCIENCE AND ENGINEERING PROGRAM

EDUCATIONAL OBJECTIVES

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

PROGRAM EDUCATIONAL OBJECTIVES:

PEO1. Excellence in Career

Students will establish themselves as effective professionals by solving real problems through the use of computer science knowledge and with attention to team work, effective communication, critical thinking and problem solving skills.

PEO2. Professional Effectiveness and Contribution to Society

Students will develop professional skills that prepare them for immediate employment and for life-long learning in advanced areas of computer science and related fields.

PEO3. Continuing Education

Students will demonstrate their ability to adapt to a rapidly changing environment by having learned and applied new skills and new technologies.

PEO4. Exercising Leadership

Students will be provided with an educational foundation that prepares them for excellence, leadership roles along diverse career paths with encouragement to professional ethics and active participation needed for a successful career.

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

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

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

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

- Adoptability and accommodative mind set to suit modern world and changing economies.
- By working hard in the chosen field and sharing the professional experience at different forums within and outside the country.

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

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

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

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

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

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

3. B. TECH - COMPUTER SCIENCE AND ENGINEERING PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

A graduate of the Computer Science and Engineering Program Outcomes will demonstrate:

PROGRAM OUTCOMES:

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

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

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

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

PO5. Modern Tool Usage
Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

PO6. The Engineer and Society
Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

PO7. Environment and Sustainability
Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PO8. Ethics
Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO9. Individual and Team Work
Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO10. Communication
Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

PO11. 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

PO12. Life-long Learning

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

PROGRAM SPECIFIC OUTCOMES

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. Problem-solving skills

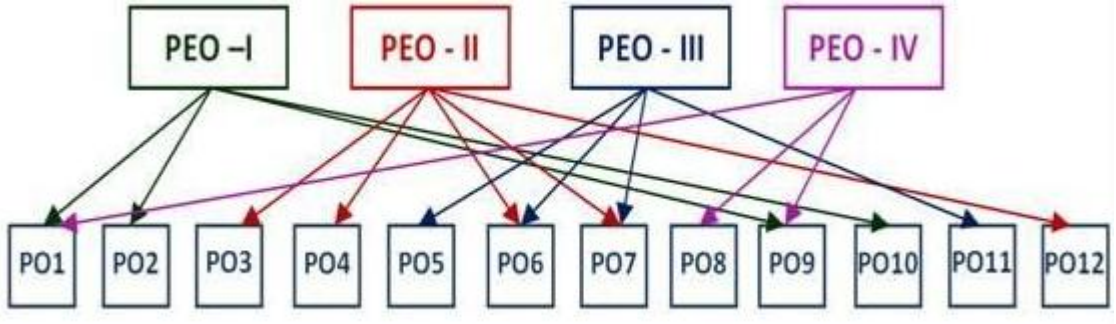
The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.

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



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	Students will establish themselves as effective professionals by solving real problems through the use of computer science knowledge and with attention to team work,effectivecommunication, critical thinking and problem solving	**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**

	skills.		Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
		PSO1	**Professional Skills** 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
II	Students will develop professional skills that prepare them for immediate employment and for life-long learning in advanced areas of computer science and related fields.	**PO3**	**Design/Development of Solutions** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
		PO4	**Conduct Investigations of Complex Problems** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
		PO5	**Modern Tool Usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
		PO6	**The Engineer and Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
		PSO1	**Professional Skills** 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	**Problem-solving skills** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.
III	Students will demonstrate their ability to adapt to a rapidly changing environment by having learned and applied new skills and new technologies.	**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 **PO12** **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 **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.
IV	Students will be provided with an educational foundation that prepares them for excellence, leadership roles along diverse career paths with encouragement to professional ethics and active participation needed for a successful career. .	**PO7**	**Environment and Sustainability** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development **PO8** **Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **PO9** **Individual and Team Work** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **PO10** **Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions **PSO3** **Successful career and Entrepreneurship** 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.

5. RELATION BETWEEN THE PROGRAM OUTCOMES AND PROGRAM EDUCATIONAL OBJECTIVES

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

PEOs → / POs ↓	(1) Excellence in Career	(2) Professional Effectiveness And Contribution	(3) Continuing Education	(4) Exercising Leadership

			to Society		
PO1	Engineering Knowledge	3		2	3
PO2	Problem Analysis	3		2	
PO3	Design/Development of Solutions	2	3	2	
PO4	Conduct Investigations of Complex Problems	2	3		
PO5	Modern Tool Usage		S	3	
PO6	The Engineer and Society	2	3	3	
PO7	Environment and Sustainability	2	3	3	
PO8	Ethics				3
PO9	Individual and Team work	3			3
PO10	Communication	3			2
PO11	Project Management and Finance		2	3	
PO12	Life-long Learning		3		2

Relationship between Program Outcomes and Program Educational Objectives
Key: 3 = Highly Related; 2 = Supportive

RELATION BETWEEN THE PROGRAM SPECIFIC OUTCOMES AND THE PROGRAM EDUCATIONAL OBJECTIVES

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

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

Relationship between Program Specific Outcomes and Program Educational Objectives
Key: 3 = Highly Related; 2 = Supportive

Note:

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

6. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES OF (B.Tech) CSE 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 Computer Science and Engineering student will demonstrate the following attributes by the time they graduate:

PO1. Engineering Knowledge

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

Performance Criteria Definitions

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

PO2. Problem Analysis

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

Performance Criteria Definitions

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

PO3. Design/Development of Solutions

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

Performance Criteria Definitions

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

PO4. Conduct Investigations of Complex Problems

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

Performance Criteria Definitions

- Identify problem/purpose
- Prepare hypothesis
- Outline procedure
- List materials and equipment
- Conduct experiment
- Record observations, data and results
- Perform analysis

- Document conclusions

PO5. Modern Tool Usage

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

Performance Criteria Definitions

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

PO6. The Engineer and Society

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

Performance Criteria Definitions

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

PO7. Environment and Sustainability

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

Performance Criteria Definitions

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

PO8. Ethics

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

Performance Criteria Definitions

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

PO9. Individual and Team Work

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

Performance Criteria Definition

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

PO10. Communication

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

Performance Criteria Definitions

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

PO11. Project Management and Finance

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

Performance Criteria Definitions

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

PO12. Life-long Learning

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

Performance Criteria Definitions

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

PROGRAM SPECIFIC OUTCOMES OF (B.Tech)CSE 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.

Performance Criteria Definitions

- Significantly contributing and delivery of desired engineering component, product or process
- Formulating and solving, moderately complex Computer Science and Engineering problems
- Skillful use of state-of-the-art tools for Computer Science and Engineering processes
- Making practical recommendations that address issues related to Computer Science and Engineering product and systems.

PSO2. Problem-solving skills

The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success. *Performance Criteria Definitions*

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

PSO3. Successful career and Entrepreneurship

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

Performance Criteria Definitions

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

Courses offered in Computer Science and Engineering Curriculum (IARE-R18) –Vs- Program Outcomes and Program Specific Outcomes Attained through course modules for I-I, I-II Semesters

Code	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I SEMESTER																
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 Practises Laboratory	√				√							√	√		
II SEMESTER																
AHSB01	English										√	√				√
AHSB12	Probability And Statistics	√	√		√									√		
AHSB13	Semiconductor Physics	√	√			√								√		
ACSB01	Programming For Problem Solving	√	√	√		√							√	√	√	√
ACSB02	Programming For Problem Solving laboratory	√	√	√		√		√					√	√	√	√
AHSB08	English Language and communication Skills laboratory										√	√				√
AHSB10	Engineering physics Laboratory	√		√		√								√		
AMEBO2	Engineering Graphics And Design Laboratory	√	√	√												√

7. PROCEDURES FOR OUTCOME DELIVERY AND ASSESSMENT WITH RESPECT TO

PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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

PO1: Engineering Knowledge **Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems**			
AHSB02	Linear Algebra and Calculus	AHSB03	Engineering Chemistry
AEEB01	Fundamentals Of Electrical Engineering	AHSB09	Engineering Chemistry Laboratory
AEEB05	Fundamentals Of Electrical Engineering Laboratory	AHSB12	Probability And Statistics
AHSB13	Semiconductor Physics	ACS002	Programming For Problem Solving
AMEB01	Workshop Manufacturing Practises Laboratory	ACSB02	Programming For Problem Solving laboratory
AHSB10	Engineering physics Laboratory	AMEBO2	Engineering Graphics And Design Laboratory
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**			
AHS002	Linear Algebra and Ordinary Differential Equations	AIT001	Design and Analysis of Algorithms
AHSB02	Linear Algebra and Calculus	AHSB03	Engineering Chemistry
AEEB01	Fundamentals Of Electrical Engineering	AHSB09	Engineering Chemistry Laboratory
AEEB05	Fundamentals Of Electrical Engineering Laboratory	AHSB12	Probability And Statistics
AHSB13	Semiconductor Physics	ACS002	Programming For Problem Solving
ACSB02	Programming For Problem Solving laboratory	AMEB02	Engineering Graphics And Design Laboratory

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**			
AHSB09	Engineering Chemistry Laboratory	AEEB05	Fundamentals Of Electrical Engineering Laboratory
ACS002	Programming For Problem Solving	ACSB02	Programming For Problem Solving laboratory
AHSB10	Engineering physics Laboratory	AMEB2	Engineering Graphics And Design Laboratory

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**			
AEEB05	Fundamentals Of Electrical Engineering Laboratory	AHSB12	Probability And Statistics

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**			
AEEB05	Fundamentals Of Electrical Engineering Laboratory	AHSB13	Semiconductor Physics
ACS002	Programming For Problem Solving	AMEB01	Workshop Manufacturing Practises Laboratory
ACSB02	Programming For Problem Solving laboratory	AHSB10	Engineering physics 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		

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	ACSB02	Programming For Problem Solving laboratory

PO8: Ethics **Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice**			
AHSB01	English		

PO9: Individual and Team Work **Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings**			
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**			
AHSB01	English	AHSB08	English Language and communication Skills laboratory

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**			
AHSB01	English	AHSB08	English Language and communication Skills laboratory

PO12: 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**			
ACS002	Programming For Problem Solving	AMEB01	Workshop Manufacturing Practises Laboratory
ACSB02	Programming For Problem Solving laboratory		

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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	AHSB03	Engineering Chemistry
AHSB12	Probability And Statistics	AHSB13	Semiconductor Physics
ACS002	Programming For Problem Solving	AMEB01	Workshop Manufacturing Practises Laboratory
ACSB02	Programming For Problem Solving laboratory	AHSB10	Engineering physics Laboratory
AMEBO2	Engineering Graphics And Design Laboratory		

PSO2: Problem-solving skills **The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.**			
AEEB01	Fundamentals Of Electrical Engineering	AHSB09	Engineering Chemistry Laboratory
AEEB05	Fundamentals Of Electrical Engineering Laboratory	ACS002	Programming For Problem Solving
ACSB02	Programming For Problem Solving laboratory		
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**.			
AHSB09	Engineering Chemistry Laboratory	AHSB01	English
ACS002	Programming For Problem Solving	ACSB02	Programming For Problem Solving laboratory
AHSB08	English Language and communication Skills laboratory		

8. METHODS OF MEASURING LEARNING OUTCOMES AND VALUE ADDITION

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

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

The above assessment indicators are detailed below.

i. Mid Semester Course Evaluation

Mid semester course reviews are conducted for all courses by the department. All students are encouraged to actively participate in this evaluation process. These evaluations are critically reviewed by HOD and senior faculty and the essence is communicated to the faculty concerned to

analyze, improve and practice so as to improve the performance of the student.

ii. End-of Semester Course Evaluation

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

iii. Continuous Evaluation of Classroom Performance

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

iv. Course Objective Surveys

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

v. Course Instructor's Evaluations

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

vi. Graduating Senior's Survey

The graduating seniors 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 Computer Science and 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 Data Mining techniques.
- The students will appreciate knowledge discovery from Data Mining 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 Database Repositories.
- The students will be able to identify the characteristics of Classification techniques from other Data Mining techniques.

Incorporating Critical Thinking Skills into Expected Learning Outcomes Statements

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

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

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

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

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

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

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

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

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

List of Action Words Related to Critical Thinking Skills

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

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

4. TIPS FOR DEVELOPING COURSE LEVEL EXPECTED LEARNING OUTCOMES STATEMENTS

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

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

5. SAMPLE EXPECTED LEARNING OUTCOMES STATEMENTS

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

Computer Networks:

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

1. Understand basic computer network technology.
2. Understand and explain Data Communications System and its components.
3. Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer.
4. Identify the different types of network topologies and protocols.
5. Identify the shortest path in a given network.
6. Model mathematically various error control schemes.
7. Analyze different LLC multiplexing mechanisms, node-to-node flow and error control.
8. Analyze different MAC mechanisms (Aloha, Slotted Aloha, TDMA, FDMA) and understand their pros and cons.
9. Identify the different types of network devices and their functions within a network.
10. Enable to interconnect various heterogeneous networks.
11. Understand and building the skills of sub netting and routing mechanisms.
12. Design and implement a peer to peer file sharing application utilizing application layer protocols such as HTTP, DNS, and SMTP and transportation layer protocol.
13. Predict ethical, legal, security and social issues related to computer networks.

Linux Programming:

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

1. Identify and use Linux utilities to create and manage simple file processing operations, organize directory structures with appropriate security.
2. Develop shell scripts to perform more complex tasks.
3. Illustrate file processing operations such as standard I/O and formatted I/O.
4. Generalize Signal generation and handling signals.
5. Develop programs using different Inter Process Communication (IPC) Mechanisms.

6. Use multithreading concepts to reduce the wastage of CPU time.
7. Design various client server applications using TCP or UDP protocols.

Operating Systems:

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

1. Understand the difference between different types of modern operating systems, virtual machines and their structure of implementation and applications.
2. Understand the difference between process & thread, issues of scheduling of user-level processes/ threads and their issues.
3. Produce customized algorithmic solutions for given synchronization problems.
4. Use modern operating system calls and synchronization libraries in software/ hardware interfaces.
5. Identify the rationale behind various memory management techniques along with issues and challenges of main memory, virtual memory and file system.
6. Infer the performance of page replacement algorithms in various scenarios.
7. Recognize the issues related to file system interface and implementation, disk management.
8. Compare and Contrast the time complexities of various disk scheduling algorithms.
9. Understand the concepts of deadlock in operating systems and how they can be managed / avoided and implement them in multiprogramming system.

6. AN OVERVIEW OF ASSESSMENT

What is assessment?

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

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

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

What is the difference between "evaluation" and "assessment"?

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

While evaluation is an important component of most classrooms, it does have some limitations. For example, if the class average on an exam is a 45%, is seems pretty clear that something went wrong along the way.

When one has only evaluated the final learning product, it can be challenging to go back and discover what happened. It can also be difficult to address the situation or provide opportunities for students to learn from their mistakes. Yes, a curve on an exam can help address a low class average, but does it help the students learn? Engaging in informal assessment activities throughout the course can help avoid this situation.

What is involved in the assessment process?

1. Establishing expected learning outcomes for the course;
2. Systematically gathering, analyzing, and interpreting evidence (through formal assessment activities such as exams or papers and informal assessment activities such as in-class discussions exercises) to determine how well the students' learning matches:
    - Faculty expectations for what students will learn and
    - The stated expected learning outcomes for the course
3. Faculty members should use this evidence/assessment of student learning to:
    - Provide questionery to students about their learning (or lack thereof) and
    - Adjust their teaching methods and/or students' learning behaviors to ensure greater student learning (Maki, 2004).

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

7. DESCRIPTION OF A COURSE PURPOSE

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

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

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

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

How advanced is this course?

- Is this course an undergraduate or graduate course?
- Where does this course fall in students' degree plan - as an introductory course or an advanced course?
- Can I expect the students taking this course to know anything about the course topic?

- Are other faculty members counting on students who have taken this course to have mastered certain knowledge or skills?

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

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

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

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

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

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

Please take a moment to think about the student learners in the course. Please consider the following questions:

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

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

The "Course Description" contains the following contents:

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

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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

COMPUTER SCIENCE AND ENGINEERING

COURSE DESCRIPTOR

Course Title	**PROGRAMMING FOR PROBLEM SOLVING**				
Course Code	ACSB01				
Programme	B.Tech				
Semester	I	AE | ME			
	II	CSE | IT | ECE |EEE | CIVIL			
Course Type	Foundation				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	0	3	4	2
Chief Coordinator	Ms. N Jayanthi, Assistant Professor Ms. B Tejaswi, Assistant Professor				
Course Faculty	Dr. J Sirisha Devi, Professor Dr. B Venkateswara Rao, Professor Mr. N Poornachandra Rao, Assistant Professor Mr. P Ravinder, Assistant Professor Mr. B Padmaja, Associate Professor Ms. A Jayanthi, Assistant Professor Mr. S Laxman Kumar, Assistant Professor Ms. S Swarajya Lakshmi, Assistant Professor Ms. A Soujanya, Assistant Professor Mr. Ch Suresh Kumar Raju, Assistant Professor				

I. COURSE OVERVIEW

The course covers the basics of programming and demonstrates fundamental programming techniques, customs and terms including the most common library functions and the usage of the preprocessor. This course helps the students in gaining the knowledge to write simple C language applications, mathematical and engineering problems. This course helps to undertake future courses that assume this programming language as a background in computer programming. Topics include

variables, data types, functions, control structures, pointers, strings, arrays and dynamic allocation principles. This course in reached to student by power point presentations, lecture notes, and lab involve the problem solving in mathematical and engineering areas.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
-	-	-	Basic Programming Concepts	-

III MARKS DISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Programming for Problem Solving	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 modules and each modules 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 module. 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 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT)

Table 1: Assessment pattern for CIA

Component	**Theory**			**Total Marks**
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four 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 - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

The AAT chosen for this course is given in section XI.

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/Quiz
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	2	Assignments/Quiz
PO 3	**Design / development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	-
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.	3	-
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	-

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 understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexity.	3	Assignments/Quiz
PSO 2	**Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.	3	Assignments/Quiz
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.	3	-

3 = High; 2 = Medium; 1 = Low

VIII COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Learn adequate knowledge by problem solving techniques.
II	Understand programming skills using the fundamentals and basics of C Language.
III	Improve problem solving skills using arrays, strings, and functions
IV	Understand the dynamics of memory by pointers.
V	Study files creation process with access permissions.

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
ACSB01.01	CLO 1	Identify and understand the working of key components of a computer system.	PO 1,PO2	2
ACSB01.02	CLO 2	Analyze a given problem and develop an algorithm to solve the problem.	PO 1,PO2	2
ACSB01.03	CLO 3	Describe the fundamental programming constructs and articulate how they are used to develop a program with a desired runtime execution flow.	PO 1,PO2	2
ACSB01.04	CLO 4	Gain knowledge to identify appropriate C language constructs to write basic programs.	PO 2,PO3	3
ACSB01.05	CLO 5	Identify the right data representation formats based on the requirements of the problem.	PO 2,PO12	2
ACSB01.06	CLO 6	Describe the operators, their precedence and associativity while evaluating expressions in program statements..	PO 1,PO2,PO3	3
ACSB01.07	CLO 7	Understand branching statements, loop statements and use them in problem solving.	PO 2	2
ACSB01.08	CLO 8	Learn homogenous derived data types and use them to solve statistical problems.	PO 1,PO2,PO3	3
ACSB01.09	CLO 9	Identify the right string function to write string programs.	PO 1,PO2,PO3	3
ACSB01.10	CLO 10	Understand procedural oriented programming using functions.	PO 1,PO2,PO3,PO5	3
ACSB01.11	CLO 11	Understand how recursion works and write programs using recursion to solve problems.	PO ,PO3	2
ACSB01.12	CLO 12	Differentiate call by value and call by reference parameter passing mechanisms.	PO 2,PO3	2
ACSB01.13	CLO 13	Understand storage classes and preprocessor directives for programming	PO 1,PO2,PO5	3
ACSB01.14	CLO 14	Understand pointers conceptually and apply them in C programs.	PO 1,PO2,PO3	3
ACSB01.15	CLO 15	Distinguish homogenous and heterogeneous data types and apply them in solving data processing applications.	PO 1,PO2	2
ACSB01.16	CLO 16	Explain the concept of file system for handling data storage and apply it for solving problems	PO 1,PO2,PO5	3
ACSB01.17	CLO 17	Differentiate text files and binary files and write the simple C programs using file handling functions.	PO 1,PO2	2
ACSB01.18	CLO 18	Apply the concepts to solve real-time applications using the features of C language.	PO 2, PO 12	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACSB01.19	CLO 19	Gain knowledge to identify appropriate searching and sorting techniques by calculating time complexity for problem solving.	PO 2,PO3,PO12	3
ACSB01.20	CLO 20	Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations.	PO 5,PO12	2
ACSB01.09	CLO 9	Identify the right string function to write string programs.	PO 1,PO2,PO3	3

3 = High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3		1										2	2	2
CLO 2	3	2											2	2	
CLO 3	3	2											3	2	
CLO 4	1	3	2										1	3	
CLO 5		2										2	3		
CLO 6	2	3	2											3	
CLO 7		2	2											3	
CLO 8	3	2	1										2	3	
CLO 9	2	3	1										2	3	
CLO 10	2	3	1		1								1	3	1
CLO 11		2	3										2	3	1
CLO 12		2	3										3	2	
CLO 13	3	2			2									3	
CLO 14	3	2	2										2	3	
CLO 15	2	3											3		
CLO 16	3	2			2								1	1	
CLO 17	3	2											2	3	
CLO 18		3										2			3
CLO 19		3	3									2		3	
CLO 20					2							3			3

3 = High; 2 = Medium; 1 = Low

XI ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1	SEE Exams	PO 1	Assignments	PO 1	Seminars	PO 2
Laboratory Practices	PO 2	Student Viva	PO 2	Mini Project	-	Certification	PO 1
Term Paper	-						

XII ASSESSMENT METHODOLOGIES - INDIRECT

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

XII SYLLABUS

Module-I	**INTRODUCTION**	**Classes: 10**
Introduction to Programming: Computer system, components of a computer system, computing environments, computer languages, creating and running programs, Algorithms, flowcharts; Introduction to C language: Computer languages, History of C, basic structure of C programs, process of compiling and running a C program, C tokens, keywords, identifiers, constants, strings, special symbols, variables, data types; Operators and expressions.		
Module-II	**CONTROL STRUCTURES**	**Classes: 08**
Conditional Control structures: Decision statements; Simple if, if-else, else if ladder, Nested if and Case Statement-switch statement; Loop control statements: while, for and do while loops. jump statements, break, continue, goto statements.		
Module-III	**ARRAYS AND FUNCTIONS**	**Classes: 10**
Arrays: Concepts, one dimensional arrays, declaration and initialization of one dimensional arrays, two dimensional arrays, initialization and accessing, multi-dimensional arrays; Strings: Arrays of characters, variable length character strings, inputting character strings, character library functions, string handling functions. Functions: Need for user defined functions, function declaration, function prototype, category of functions, inter function communication, function calls, parameter passing mechanisms, recursion, passing arrays to functions, passing strings to functions, storage classes, preprocessor directive		

Module-IV	STRUCTURES, UNIONS AND POINTERS	Classes: 09
Structures and unions: Structure definition, initialization, accessing structures, nested structures, arrays of structures, structures and functions, passing structures through pointers, self-referential structures, unions, bit fields, typedef, enumerations; Pointers: Pointer basics, pointer arithmetic, pointers to pointers, generic pointers, array of pointers, pointers and arrays, pointers as functions arguments, functions returning pointers. Dynamic memory allocation: Basic concepts, library functions.		
Module-V	**FILE HANDLING AND BASICALGORITHMS**	**Classes: 08**
Files: Streams, basic file operations, file types, file opening modes, input and output operations with files, special functions for working with files, file positioning functions, command line arguments. Searching, basic sorting algorithms (bubble, insertion, selection), algorithm complexity through example programs (no formal definitions required).		

Text Books:

1. Byron Gottfried, "Programming with C",Schaum's Outlines Series, McGraw Hill Education, 3rd Edition, 2017.
2. E. Balagurusamy, "Programming in ANSI C", McGraw Hill Education, 6th Edition, 2012.

Reference Books:

1. W. Kernighan Brian, Dennis M. Ritchie, "The C Programming Language", PHI Learning, 2nd Edition, 1988.
2. Yashavant Kanetkar, "Exploring C", BPB Publishers, 2nd Edition, 2003.
3. Schildt Herbert, "C: The Complete Reference", Tata McGraw Hill Education, 4th Edition, 2014.
4. R. S. Bichkar, "Programming with C", Universities Press, 2nd Edition, 2012.
5. Dey Pradeep, Manas Ghosh, "Computer Fundamentals and Programming in C", Oxford University Press, 2nd Edition, 2006.
6. Stephen G. Kochan, "Programming in C", Addison-Wesley Professional, 4th Edition, 2014.
7. B. A. Forouzan, R. F. Gillberg, "C Programming and Data Structures", Cengage Learning, India, 3rd Edition, 2014.N. P. Bali, "Engineering Mathematics", Laxmi Publications, 9th Edition, 2016.

Web References:

1. https://www.bfoit.org/itp/Programming.html
2. https://www.khanacademy.org/computing/computer-programming
3. https://www.edx.org/course/programming-basics-iitbombayx-cs101-1x-0
4. https://www.edx.org/course/introduction-computer-science-harvardx-cs50x

E-Text Books:

1. http://www.freebookcentre.net/Language/Free-C-Programming-Books-Download.htm
2. http://www.imada.sdu.dk/~svalle/courses/dm14-2005/mirror/c/
3. http://www.enggnotebook.weebly.com/uploads/2/2/7/1/22718186/ge6151-notes.pdf

MOOC Course:

1. https://www.alison.com/courses/Introduction-to-Programming-in-c
2. http://www.ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-s096-effective-programming-in-c- and-c-january-iap-2014/index.htm

XIV COURSE PLAN:

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

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
1 – 2	Introduction to Computers: computer systems, computing environments, Computer languages, creating and running programs	CLO 1	T2:1.1-1.2
3 – 4	Algorithms, flowcharts; Introduction to C language: Computer languages, History of C, basic structure of C programs, process of compiling and running a C program	CLO 2	T2:2.1-2.2
5 – 6	C tokens, keywords, identifiers, constants, strings	CLO 2	T2:1.4-1.5
7 – 8	Special symbols, variables, data types	CLO 3	T2:2.1-2.2
9 – 10	Operators and expressions	CLO 3	T2: 2.3-2.6,7
11 – 12	Simple if, if-else, else if ladder, Nested if and Case Statement-switch statement	CLO 3	T2:3.1-3.5
13 – 14	While, for and do while loops	CLO 5	T2: 5.2-5.3
15 – 16	Jump statements, break, continue, goto statements	CLO 7	T2: 6.1-6.6
17 – 18	Concepts, one dimensional arrays, declaration and initialization of one dimensional arrays	CLO 9	T2: 6.7
19 – 20	Two dimensional arrays, initialization and accessing	CLO 13	T2: 8.1-8.3,8.7-8.8
21-22	Multi-dimensional arrays; Strings: Arrays of characters	CLO 13	T2: 11.1-11.5
23-- 24	Variable length character strings, inputting character strings, character library functions, string handling functions	CLO 15	T2: 4.1-4.5
25	Need for user defined functions, function declaration, function prototype	CLO 15	T1:7 T2: 6.9 T2:G.1
26-27	Category of functions, inter function communication, function calls	CLO 11	T1:10 T2:10.1-10.2
28 – 29	Parameter passing mechanisms, recursion, passing arrays to functions, passing strings to functions,	CLO 16	T2:10.3-10.5
30 – 31	Storage classes ,preprocessor directive	CLO 16	T1:8
32 – 33	Structure definition, initialization, accessing structures, nested structures	CLO 16	T2: 12.3-12.4
34 – 35	Unions, C programming examples, BitFields, typedef, enumerations	CLO 16	T2:12.4 T2:12.1-12.2
36 -- 38	Arrays of structures, structures and functions, passing structures through pointers, self-referential structures	CLO 17	T2:2.1-2.2
39 – 40	Unions, bit fields, typedef, enumerations	CLO 17	T2: 2.3-2.6,7
41 – 42	Pointer basics, pointer arithmetic, pointers to pointers, generic pointers, array of pointers, pointers and arrays	CLO 19	T2:3.1-3.5
43 – 44	Pointers as functions arguments, functions returning pointers	CLO 19	T2: 5.2-5.3
45	Dynamic memory allocation: Basic concepts, library functions	CLO 20	T2: 6.1-6.6
39	Streams, basic file operations, file types, file opening modes, input and output operations with files	CLO 20	T2:10.4

Lecture No	Topic/s to be covered	Course Learning Outcomes (CLOs)	Reference
40-41	Special functions for working with files, file positioning functions	CLO 21	R3:12.1-12.3
42	Command line arguments. Searching	CLO 22	R3:12.4
43	Sorting algorithms bubble, insertion, selection	CLO 23	T2:11.4 R7:13.1-13.3
44-45	Algorithm complexity through example programs	CLO 23	T2:11.4 R7:13.1-13.3

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

S No	Description	Proposed Actions	Relevance With POs	Relevance With PSOs
1	Assist student to design system calls in operating systems	Seminars	PO 1	PSO 1
2	Stimulate students to develop graphics programming	Seminars/ NPTEL	PO 2	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	1. Build IT 2. Proficiency Test 3. Coding Hackthon/ Competitions	PO 2	PSO 1

XVI DESIGN BASED PROBLEMS (DP) / OPEN ENDED PROBLEM:

1. Develop simple character-based Chess-game supporting standard partial chess moves. Chess board should be 8x8 Cell Board having each Cell of 4 characters. Basic chess board with empty shell should have W... Cell and B... For Black Cell. Wherever any player‟s Game elements such as Rook or Camel or King or Queen is on board Cell then it. Then it should be displayed such as BQN2 or WQN1 which indicated such as Queen of player-2 on black cell or queen of player-1 on white cell. Or Student can use his own conventions. Student should be able to demonstrate 5 moves for each player minimum.

2. (Airline Reservations System) A small airline has just purchased a computer for its new automated reservations system. The president has asked you to program the new system. You are to write a program to assign seats on each flight of the airline's only plane (capacity: 10 seats).

Your program should display the following menu of alternatives: Please type 1 for "first class"

Please type 2 for "economy"

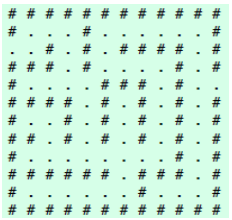
If the person types 1, then your program should assign a seat in the first class section (seats 1- 5). If the person types 2, then your program should assign a seat in the economy section (seats 6-10). Your program should then print a boarding pass indicating the person's seat number and whether it is in the first class or economy section of the plane.

Use a single-subscripted array to represent the seating chart of the plane. Initialize all the elements of the array to 0 to indicate that all seats are empty. As each seat is assigned, set the corresponding elements of the array to 1 to indicate that the seat is no longer

available.

Your program should, of course, never assign a seat that has already been assigned. When the first class section is full, your program should ask the person if it is acceptable to be placed in the economy section (and vice versa). If yes, then make the appropriate seat assignment. If no, then print the message "Next flight leaves in 3 hours.

3. (Maze Traversal) The following grid is a double-subscripted array representation of a maze.



The # symbols represent the walls of the maze, and the periods (.) represent squares in the possible paths through the maze. There is a simple algorithm for walking through a maze that guarantees finding the exit (assuming there is an exit). If there is not an exit, you will arrive at the starting location again. Place your right hand on the wall to your right and begin walking forward. Never remove your hand from the wall. If the maze turns to the right, you follow the wall to the right. As long as you do not remove your hand from the wall, eventually you will arrive at the exit of the maze. There may be a shorter path than the one you have taken, but you are guaranteed to get out of the maze. Write recursive function mazeTraverse to walk through the maze. The function should receive as arguments a 12-by-
12 character array representing the maze and the starting location of the maze. As mazeTraverse attempts to locate the exit from the maze, it should place the character X in each square in the path. The function should display the maze after each move so the user can watch as the maze is solved.

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