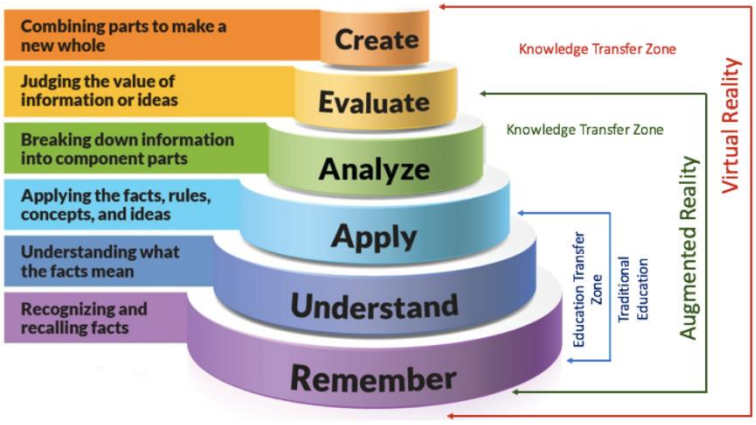
OUTCOME BASED EDUCATION BOOKLET

ELECTRONICS AND COMMUNICATION ENGINEERING

M.Tech

For the Masters of Students admitted during

Academic Year 2016-17 & 2017-18



.....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

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

Mission

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

Contents

Program Education Objectives and Outcomes

As Per NBA Norms Post June, 2016

Semester: I-I, I-II, II-I, II-II

Part – I

PROGRAM EDUCATIONAL OBJECTIVES AND OUTCOMES

First version 22 July, 2014

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

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

1. PROGRAM EDUCATIONAL OBJECTIVES, OUTCOMES AND ASSESSMENT CRITERIA

Learning Outcomes, Assessment Criteria

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

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

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

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

2. M. TECH – EMBEDDED SYSTEMS PROGRAM

EDUCATIONAL OBJECTIVES

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

PROGRAM EDUCATIONAL OBJECTIVES:

PEO1. Research and development

Be successful practicing professionals or pursue doctoral studies in allied areas, contributing significantly to **research and development** activities

PEO2. Demonstrate

Demonstrate technical competence, such as identifying, formulating, analyzing, and creating engineering solutions using appropriate current embedded engineering techniques, skills, and tools.

PEO3. Communicate

To work and **communicate** effectively in inter-disciplinary environment, either in a team or independently and establish leadership qualities.

PEO4. Apply

An ability to **apply** in-depth knowledge to evaluate, analyze and synthesize existing and novel designs.

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

i. To prepare the students who will be able to attain a solid foundation in Embedded systems fundamentals with an attitude to pursue continuing education.

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

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

- Adoptability and accommodative mind set to suit modern world and changing economies.

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

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

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

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

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

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

3. M. TECH –EMBEDDED SYSTEMS PROGRAM OUTCOMES:

Masters of the embedded systems Program Outcomes will demonstrate:

PROGRAM OUTCOMES:

PO1. Engineering Knowledge

Apply advanced level knowledge, techniques, skills and modern tools in the field of Embedded Systems and sub areas IoT, Processor technology, and Storage technology.

PO2. Teamwork and Project Management

Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.

PO3. Develop and Novel Designs

Respond to global policy initiatives and meet the emerging challenges with sustainable technological solutions in the field of electronic product designing.

PO4. Analyze Complex Systems

Demonstrate the importance of embedded technologies and design new innovative products for solving society relevant problems.

PO5. Technical Presentation Skills

Write and present a substantial technical report / document.

PO6. Development of Solutions

Independently carry out research / investigation and development work to solve practical problems.

PO7. Lifelong learning

Recognize the need to engage in lifelong learning through continuing education and research.

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

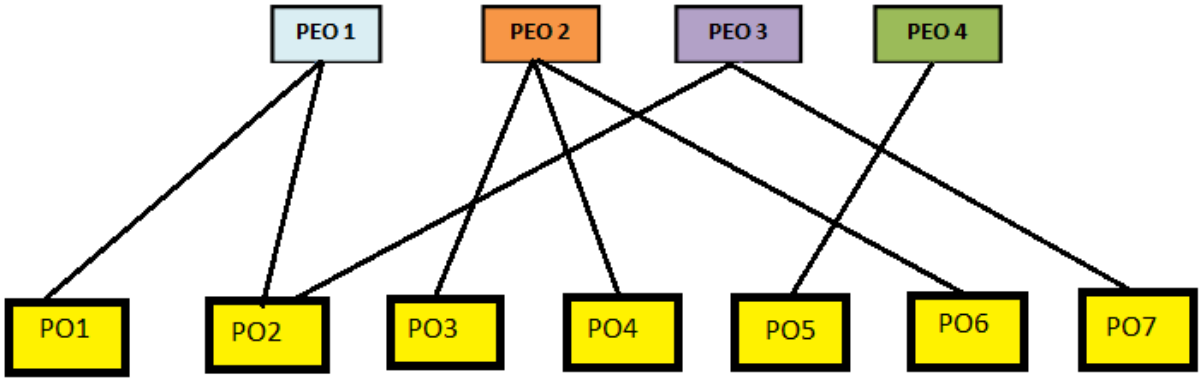


Figure: *Correlation between the PEOs and the POs*

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

	Program Educational Objectives		Program Outcomes
I	Be successful practicing professionals or pursue doctoral studies in allied areas, contributing significantly to **research and development** activities	**PO1**	**Engineering Knowledge** Apply advanced level knowledge, techniques, skills and modern tools in the field of Embedded Systems and sub areas IoT, Processor technology, and Storage technology.
		PO2	**Teamwork and Project Management** Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.
II	To be in a position to analyze real life problems and design socially accepted and economically feasible solutions in the respective fields.	**PO3**	**Develop and Novel Designs** Respond to global policy initiatives and meet the emerging challenges with sustainable technological solutions in the field of electronic product designing.
		PO4	**Analyze Complex Systems** Demonstrate the importance of embedded technologies and design new innovative products for solving society relevant problems.
		PO6	**Development of Solutions** Independently carry out research / investigation and development work to solve practical problems.
III	To work and **communicate** effectively in inter-disciplinary environment, either	**PO2**	**Teamwork and Project Management** Function on multidisciplinary environments by

	independently or in a team, and establish leadership qualities.		working cooperatively, creatively and responsibly as a member of a team.
		PO7	**Lifelong learning** Recognize the need to engage in lifelong learning through continuing education and research.
IV	An ability to **apply** in-depth knowledge to evaluate, analyze and synthesize existing and novel designs.	**PO5**	**Technical Presentation Skills** Write and present a substantial technical report / document.

5. RELATION BETWEEN THE PROGRAM OUTCOMES AND PROGRAM EDUCATIONAL OBJECTIVES

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

POs \ PEOs →		(1) Research and development	(2) Demonstrate	(3) Communicate	(4) Apply
PO1	Engineering Knowledge	3			
PO2	Teamwork and Project Management	3		1	
PO3	Develop and Novel Designs		3		
PO4	Analyze Complex Systems		3		
PO5	Technical Presentation Skills				3
PO6	Development of Solutions		3		
PO7	Lifelong learning			3	

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

6. PROGRAM OUTCOMES OF (M.Tech) EMBEDDED SYSTEMS MASTERS

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

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

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

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. Teamwork and Project Management

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

PO3. Develop Novel designs

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

PO4. Analyze Complex Systems

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. Technical Presentation skills

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

PO6. 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

PO7. 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

Courses offered in Embedded systems Curriculum (IARE-R16) –Vs- Program Outcomes Attained through course modules for I-I, I-II, II-I, II-II Semesters

Code	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7
I SEMESTER								
BES001	Embedded C	√	√	√	√		√	
BES002	Wireless LANs and PANs	√	√	√			√	
BES003	Computer Architecture	√			√	√	√	√
BES204	Hardware Software Co-Design	√	√	√	√		√	
BES209	Embedded Networking	√	√	√	√		√	
BAE701	Introduction to Aerospace Engineering	√				√		√
BES101	Embedded Programming Laboratory	√	√	√	√	√	√	√

Code	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7
II SEMESTER								
BES004	Embedded System Architecture	√	√	√			√	
BES005	FPGA Architecture and Applications	√	√	√			√	√
BES006	Internet of Things	√	√	√		√		√
BES210	Embedded Wireless Sensor Networks	√	√	√	√	√		√
BES214	Embedded Real Time Operating Systems	√	√	√	√		√	
BCS703	Research Methodology	√	√	√			√	
BES102	Embedded System Laboratory	√	√	√	√		√	√
BES103	Application Development Mini Project Laboratory	√	√		√	√	√	√
III SEMESTER								
BES401	Seminar and Technical Writing	√	√	√	√	√	√	√
BES501	Comprehensive Examination	√	√	√	√	√	√	√
BES601	Project Work (Phase -I)	√	√	√	√	√	√	√
IV SEMESTER								
BES602	Project Work (Phase -II)	√	√	√	√	√	√	√

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

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

PO1:Engineering Knowledge

Apply advanced level knowledge, techniques, skills and modern tools in the field of Embedded Systems and sub areas IoT, Processor technology, and Storage technology.

BES001	Embedded C	BES004	Embedded System Architecture
BES002	Wireless LANs and PANs	BES006	Internet of Things
BES003	Computer Architecture	BES210	Embedded Wireless Sensor Networks
BES204	Hardware Software Co-Design	BES214	Embedded Real Time Operating Systems
BES209	Embedded Networking	BCS703	Research Methodology
BAE701	Introduction to Aerospace Engineering	BES102	Embedded System Laboratory
BES005	FPGA Architecture and Applications	BES401	Seminar and Technical Writing
BES101	Embedded Programming Laboratory	BES501	Comprehensive Examination
BES103	Application Development Mini Project Laboratory	BES601	Project Work (Phase -I)
BES602	Project Work (Phase -II)		

PO2: Teamwork and Project Management

Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.

BES001	Embedded C	BES004	Embedded System Architecture
BES002	Wireless LANs and PANs	BES006	Internet of Things
BES005	FPGA Architecture and Applications	BES210	Embedded Wireless Sensor Networks
BES204	Hardware Software Co-Design	BES214	Embedded Real Time Operating Systems
BES209	Embedded Networking	BCS703	Research Methodology
BES101	Embedded Programming Laboratory	BES102	Embedded System Laboratory
BES103	Application Development Mini Project Laboratory	BES401	Seminar and Technical Writing
BES602	Project Work (Phase -II)	BES501	Comprehensive Examination
		BES601	Project Work (Phase -I)

PO3: Develop and Novel Designs

Respond to global policy initiatives and meet the emerging challenges with sustainable technological solutions in the field of electronic product designing.

BES001	Embedded C	BES004	Embedded System Architecture
BES002	Wireless LANs and PANs	BES006	Internet of Things
BES005	FPGA Architecture and Applications	BES210	Embedded Wireless Sensor Networks
BES204	Hardware Software Co-Design	BES214	Embedded Real Time Operating Systems
BES209	Embedded Networking	BCS703	Research Methodology
BES101	Embedded Programming Laboratory	BES102	Embedded System Laboratory
BES602	Project Work (Phase -II)	BES401	Seminar and Technical Writing
BES601	Project Work (Phase -I	BES501	Comprehensive Examination

PO4: Analyze Complex Systems

Demonstrate the importance of embedded technologies and design new innovative products for solving society relevant problems.

BES001	Embedded C	BES210	Embedded Wireless Sensor Networks
BES003	Computer Architecture	BES214	Embedded Real Time Operating Systems
BES204	Hardware Software Co-Design	BCS703	Research Methodology
BES209	Embedded Networking	BES102	Embedded System Laboratory
BES101	Embedded Programming Laboratory	BES401	Seminar and Technical Writing
BES103	Application Development Mini Project Laboratory	BES501	Comprehensive Examination
BES602	Project Work (Phase -II)	BES601	Project Work (Phase -I)

PO5: Technical Presentation Skills

Write and present a substantial technical report / document.

BES101	Embedded Programming Laboratory	BES006	Internet of Things
BES103	Application Development Mini Project Laboratory	BES210	Embedded Wireless Sensor Networks
BES003	Computer Architecture	BES401	Seminar and Technical Writing
BAE701	Introduction to Aerospace Engineering	BES501	Comprehensive Examination
BES602	Project Work (Phase -II)	BES601	Project Work (Phase -I)

PO6: Development of Solutions

Independently carry out research / investigation and development work to solve practical problems.

BES001	Embedded C	BES004	Embedded System Architecture
BES002	Wireless LANs and PANs		
BES003	Computer Architecture	BES210	Embedded Wireless Sensor Networks

BES005	FPGA Architecture and Applications	BES214	Embedded Real Time Operating Systems
BES204	Hardware Software Co-Design	BCS703	Research Methodology
BES209	Embedded Networking	BES102	Embedded System Laboratory
BES101	Embedded Programming Laboratory	BES401	Seminar and Technical Writing
BES103	Application Development Mini Project Laboratory	BES501	Comprehensive Examination
BES602	Project Work (Phase -II)	BES601	Project Work (Phase -I)
PO7: Lifelong learning Recognize the need to engage in lifelong learning through continuing education and research.			
BES003	Computer Architecture	BES005	FPGA Architecture and Applications
BAE701	Introduction to Aerospace Engineering	BES006	Internet of Things
BES101	Embedded Programming Laboratory	BES210	Embedded Wireless Sensor Networks
BES103	Application Development Mini Project Laboratory	BES102	Embedded System Laboratory
BES602	Project Work (Phase -II)	BES401	Seminar and Technical Writing
BES601	Project Work (Phase -I)	BES501	Comprehensive Examination

8. METHODS OF MEASURING LEARNING OUTCOMES AND VALUE ADDITION

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

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

The above assessment indicators are detailed below.

i. Mid Semester Course Evaluation

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

ii. End-of Semester Course Evaluation

The end-of semester course reviews are conducted, feedback taken from students and remedial measures will be taken up such that the student gets benefited before going

for the university end exams. The positive and negative comments made by the students about the course are recorded and submitted to the departmental academic council (DAC) and to the Principal for taking necessary actions to better the course for subsequent semesters.

iii. Continuous Evaluation of Classroom Performance

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

iv. Course Objective Surveys

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

v. Course Instructor's Evaluations

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

vi. Graduating Senior's Survey

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

vii. Alumni Survey

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

viii. Employer Survey

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

ix. Laboratory and Project Works

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

x. Balanced Composition in Curriculum

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

xi. Department Academic Committee and Faculty Meetings

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

xii. Professional Societies

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

Part - II

METHODOLOGY FOR PREPARATION AND ASSESSMENT OF COURSE LEVEL STUDENT LEARNING OUTCOMES

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

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

Expected Learning Outcomes:

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

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

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

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

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

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

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

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

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

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

1. COURSE PURPOSE

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

The course purpose involves the following:

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

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

2. EXPECTED LEARNING OUTCOMES

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

Simply stated, expected learning outcome statements describe:

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

Learning outcomes have three major characteristics

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

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

3. TO DEFINE EFFECTIVE LEARNING OUTCOME STATEMENTS

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

Examples of good action words to include in expected learning outcome statements:

Compile, identify, create, plan, revise, analyze, design, select, utilize, apply, demonstrate, prepare, use, compute, discuss, explain, predict, assess, compare, rate, critique, outline, or evaluate

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

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

- The students will understand basic Electronic components.
- The students will appreciate knowledge discovery from Communication techniques.

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

- How do you observe someone "understanding" a theory or "appreciating" Data Mining techniques?
- How easy will it be to measure "understanding" or "appreciation"?

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

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

Incorporating Critical Thinking Skills into Expected Learning Outcomes Statements

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

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

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

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

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

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

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

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

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

List of Action Words Related to Critical Thinking Skills

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

REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
Choose	Classify	Apply	Analyze	Agree	Adapt
Define	Compare	Build	Assume	Appraise	Build
Find	Contrast	Choose	Categorize	Assess	Change

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

4. TIPS FOR DEVELOPING COURSE LEVEL EXPECTED LEARNING OUTCOMES STATEMENTS

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

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

5. SAMPLE EXPECTED LEARNING OUTCOMES STATEMENTS

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

EMBEDDED NETWORKING:

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

- Outline the the concepts of Embedded Networking
- Examine the Serial/parallel Communication
- Understand the concept of RS232,RS485,I2C– pc parallel port programming
- Demonstrate the USB BUS Communication, PIC 18 microcontroller USB interface, C programs
- Illustrate the CAN bus types of errors, PIC microcontroller CAN interface, simple application with CAN
- Examine the Ethernet cables and Communication
- Describe the internet in local and communications, inside the Internet protocol.
- Outline the Hardware options, cables.
- Illustrate Exchanging messages using UDP and TCP
- Demonstrate the serving web pages that respond to user Input, email for embedded systems
- Compare the energy efficient MAC protocols, SMAC
- Demonstrate robust routing, data centric routing.
- Illustrate time synchronization network concepts

EMBEDDED C:

Students who complete this course should be able to:

- Understanding the basic concepts of Embedded C.
- Understanding the basic concept of interfacing and interrupts
- Understanding the basic of 8051 architecture
- Analyze the programming on switches
- Analysis of processor scheduling real time
- Understanding the programming language tools.
- Understanding the basic concepts of coding on embedded C.
- Applications of software on real time constraints
- Analyze the programming on object oriented
- Understanding the testing concepts on real time applications
- Understanding the basic concepts on software architecture
- Understanding the real time concepts using case study.

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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

9. REFERENCES

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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

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	**EMBEDDED SYSTEM ARCHITECTURE**				
Course Code	**BES004**				
Programme	**M.Tech**				
Semester	**II**				
Course Type	**Core**				
Regulation	**R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Practicals**	**Credits**
	3	**-**	**3**	**-**	**-**
Course Faculty	**Dr. M Ramesh Babu, Assistant Professor**				

I. COURSE OVERVIEW:

In this course, the fundamentals of embedded system hardware and software design will be explored. This course deals with general overview of embedded systems, architectural view including design process, components, software and standards. It exposes the methods and materials used in the design and development of embedded systems. It gives overview of hardware, software, product life cycle and engineering issues of software to be met.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
PG	BES003	I	Computer Architecture	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Embedded System Architecture	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	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 module carries equal weight age 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.
30 %	To test the analytical skill of the concept.
20 %	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 Technical Seminar and Term Paper.

Component	**Theory**		**Total Marks**
Type of Assessment	**CIE Exam**	**Technical Seminar and Term Paper**	
CIA Marks	25	05	30

Table 1: Assessment pattern for CIA

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 9th and 17th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:
Two seminar presentations and the term paper with overview of topic are conducted during II semester. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of Embedded Systems and sub areas IoT, Processor technology, Storage technology.	3	Seminar and Term Paper
PO 2	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	3	Seminar and Guest Lectures
PO 3	Respond to global policy initiatives and meet the emerging challenges with sustainable technological solutions in the field of electronic product designing.	3	Seminar and Guest Lectures
PO 4	Demonstrate the importance of embedded technologies and design new innovative products for solving society relevant problems	2	Guest Lecturers
PO 6	Independently carry out research/ investigation and development work to solve practical problems.	3	Seminar and Guest Lectures

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES:

The course should enable the students to:

I	Understanding of fundamental embedded systems design paradigms, architectures.
II	Interpret possibilities and challenges, both with respect to software and hardware.
III	Analyze a system both as whole and in the included parts, to understand how these parts interact in the functionality and properties of the system.

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Describe different Embedded system models, ISA architecture models.	CLO 1	Describe different Embedded system models, embedded standards, block diagrams Embedded board using von Neuman model.
		CLO 2	Demonstrate EMBEDDED processors: ISA architecture models, application specific ISA models and general purpose ISA models.
CO 2	Demonstrate Internal processor design: ALU, memory.	CLO 3	Understand Internal processor design: ALU, registers, control unit, clock management
		CLO 4	Identify different processor i/o, interrupts, processor buses, processor performance
CO 3	Distinguish different memory managements.	CLO 5	Distinguish ROM, RAM, cache , auxiliary memory, memory management.
		CLO 6	Identify performance of Board buses: Arbitration and timing, PCI bus example, integrating bus with components.
CO 4	Describe Middleware and applications and layers.	CLO 7	Understand Middleware and applications: PPP, IP middleware UDP, Java. Application layer: FTP client, SMTP, HTTP server and client.

		CLO 8	Describe Application layer: FTP client, SMTP, HTTP server and client.
CO 5	Design and development architectural patterns and reference models.	CLO 9	Design and development of architectural patterns and reference models.
		CLO 10	Creating the architectural structures and evaluating the architecture, debugging testing, and maintaining.

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
BES004.01	CLO 1	Understand the different Embedded system models, embedded standards, block diagrams Embedded board using von Neuman model.	PO 1	3
BES004.02	CLO 2	Identify different ISA architecture models, application specific ISA models and general purpose ISA models.	PO 1	3
BES004.03	CLO 3	Understand Internal processor design: ALU, registers, control unit, clock management.	PO 2, PO 3	3
BES004.04	CLO 4	Distinguish different processor i/o, interrupts, processor buses, processor performance.	PO 2	3
BES004.05	CLO 5	Understand ROM, RAM, cache, auxiliary memory, memory management.	PO 3	2
BES004.06	CLO 6	Identify performance of Board buses: Arbitration and timing, PCI bus example, integrating bus with components	PO 3, PO 4	3
BES004.07	CLO 7	Understand Middleware and applications: PPP, IP middleware UDP, Java	PO 4	3
BES004.08	CLO 8	Describe Application layer FTP client, SMTP, HTTP server and client	PO 4	2
BES004.09	CLO 9	Describe Design and development of architectural patterns and reference models	PO 1, PO 6	3
BES004.10	CLO 10	Creating the architectural structures and evaluating the architecture, debugging testing, and maintaining	PO 1, PO 6	3

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (PO)				
	PO 1	PO 2	PO 3	PO 4	PO 6
CO 1	3				
CO 2		3	3		
CO 3			3	2	
CO 4				3	
CO 5	3				3

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (PO)				
	PO 1	PO 2	PO 3	PO 4	PO 6
CLO 1	3				
CLO 2	3				
CLO 3		2	3		
CLO 4		3			
CLO 5			2		
CLO 6			3	2	
CLO 7				3	
CLO 8				2	
CLO 9	2				3
CLO 10	2				3

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO1, PO2, PO3, PO4, PO6	SEE Exams	PO1, PO2, PO3, PO6	Seminar and Term Paper	PO1, PO2, PO3, PO4, PO6
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES –INDIRECT

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

XIV. SYLLABUS:

UNIT I
INTRODUCTION TO EMBEDDED SYSTEMS Embedded system model, embedded standards, block diagrams, powering the hardware: Embedded board using von Neuman model; EMBEDDED processors: ISA architecture models, application specific ISA models and general purpose ISA models: Instruction level parallelism.
UNIT II
PROCESSOR HARDWARE Internal processor design: ALU, registers, control unit, clock, on chip memory, processor i/o, interrupts, processor buses, processor performance.
UNIT III
SUPPORT HARDWARE Board memory: ROM, RAM, cache , auxiliary memory, memory management, memory performance. Board buses: Arbitration and timing, PCI bus example, integrating bus with components, bus performance.
UNIT IV
SOFTWARE Middleware and applications: PPP, IP middleware UDP, Java. Application layer: FTP client, SMTP, HTTP server and client.
UNIT V
ENGINEERING ISSUES OF SOFTWARE Design and development: architectural patterns and reference models: Creating the architectural structures, documenting the architecture, analyzing and evaluating the architecture, debugging testing, and maintaining.
TEXT BOOKS:
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XV. COURSE PLAN:

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

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
1-3	Understand the basic concepts of Embedded system model, embedded standards	Introduction: Embedded system model, embedded standards, block diagrams powering the hardware: Embedded board using von Neuman model	T1:1.1, 1.2
4-6	Describe overall Embedded board using von Neuman model.	Powering the hardware: Embedded board using von Neuman model.	T1:2.1

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
7-9	Understand the different ISA architecture models	EMBEDDED processors: ISA architecture models, application specific ISA models and general purpose ISA models: Instruction level parallelism.	T1:2.2, 2.3
10-13	Describe Internal processor design	Internal processor design: ALU, registers, control unit, clock	T1:4.1, 4.2, 4.3
14-16	Implementing the concepts of processor.	On chip memory, processor i/o, interrupts, processor buses, processor performance.	T1:4.2, 4.4
17-20	Understand the concepts of different memories.	Board memory: ROM, RAM, cache , auxiliary memory, memory management, memory performance.	T1: 5.1, 5.2
21-22	Describe the concepts of board buses.	Board buses: Arbitration and timing, PCI bus example, integrating bus with components, bus performance.	T1:6.1, 6.2, 6.4
23-27	Understand Middleware and applications.	Middleware and applications: PPP, IP middleware UDP, Java.	T1:7.2, 7.3, 7.4
28-36	Describe Application layer and different clients.	Application layer: FTP client, SMTP, HTTP server and client.	T1:8.1, 8.3
37-40	Understand design and development of architectural patterns	Design and development: architectural patterns and reference models: Creating the architectural structures	T1:5.3
41-45	Understanding the concept of architecture.	Documenting the architecture, analyzing and evaluating the architecture, debugging testing, and maintaining.	T1:5.5, 5.6, 5.7

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

S No	Description	Proposed Actions	Relevance with POs
1	Embedded standards, block diagrams	Seminars / Guest Lectures / NPTEL	PO 1, PO 2, PO 4 PO6
2	Application layer: FTP client, SMTP	Work Shops/ Guest Lectures / NPTEL	PO 3, PO 4

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