# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad - 500 043

## MECHANICAL ENGINEERING

## COURSE DESCRIPTION FORM

| | | | | |
|---|---|---|---|---|
| **Course Title** | **Flexible Manufacturing System** | | | |
| **Course Code** | BC006 | | | |
| **Course Structure** | Lectures | Tutorials | Practicals | Credits |
| | 3 | - | - | 3 |
| **Course Coordinator** | G. Naveen Kumar, Associate Professor | | | |
| **Team of Instructors** | - | | | |

## I. COURSE OVERVIEW

Flexible Manufacturing Engineering is a sub discipline of mechanical engineering, and optical engineering concerned with designing machines, fixtures, and other structures that have exceptionally low tolerances, are repeatable, and are stable over time. These approaches have applications in machine tools.

## II. PREREQUISITE(S)

| Level | Credits | Periods/ Week | Prerequisites |
|---|---|---|---|
| PG | 3 | 3 | Operations Research, Production planning Control |

## III. MARKS DISTRIBUTION

| Subject | SEE Examination | CIA Examination | Total Marks |
|---|---|---|---|
| **Flexible Manufacturing Systems** | 70 Marks | 30 Marks | 100 Marks |

| | | |
|---|---|---|
| Semester End Examination<br>70 Marks<br>All the Units (1, 2, 3, 4 and 5) | 70 Marks<br>(3 Hours) | 5 questions to be answered. Each question carries 14 Marks |

<table>
<tr><td rowspan="6">Average of two CIA Examinations</td><td colspan="4">Continuous Internal Assessment (CIA) – 1</td></tr>
<tr><td rowspan="3">30 Marks<br>(2 Hours)</td><td rowspan="3">Units<br>I, II and<br>III (half)</td><td rowspan="2">Continuous Internal Examination (CIE)<br>(2 hours)<br>[4 questions to be answered out of 5 questions from Part- A & B]</td><td>Part - A<br>5 questions to be answered out of 5 questions, each carries 1 mark.</td></tr>
<tr><td>Part - B<br>4 questions each carry 5 marks.</td></tr>
<tr><td>Technical Seminar and Term Paper</td><td>5 marks</td></tr>
<tr><td colspan="4">Continuous Internal Assessment (CIA) – 2</td></tr>
<tr><td rowspan="3">30 Marks<br>(2 Hours)</td><td rowspan="3">Units<br>III (half)<br>IV and V</td><td rowspan="2">Continuous Internal Examination (CIE)<br>(2 hours)<br>[4 questions to be answered out of 5 questions from Part- A & B]</td><td>Part – A<br>5 questions to be answered out of 5 questions, each</td></tr>
<tr><td>Part - B<br>4 questions each carry 5 marks.</td></tr>
<tr><td>Technical Seminar and Term Paper</td><td>5 marks</td></tr>
</table>

## IV. EVALUATION SCHEME

| S. No | Component | Duration | Marks |
|---|---|---|---|
| 1 | CIE - I Examination | 2 hour | 25 |
| 2 | Technical Seminar and Term Paper | 10 minutes seminar and 1000 words document | 05 |
| TOTAL | | | 30 |
| 3 | CIE - II Examination | 2 hour | 25 |
| 4 | Technical Seminar and Term Paper | 10 minutes seminar and 1000 words document | 05 |
| TOTAL | | | 30 |
| CIA Examination marks to be considered as average of above two CIA's | | | |
| 5 | EXTERNAL Examination | 3 hours | 70 |
| GRAND TOTAL | | | 100 |

## V. COURSE OBJECTIVES

The course should enable the students to

I. **Understand** of modern trends in design and manufacturing using CAD/CAM
II. **Apply** performance analysis techniques.
III. **Understand** preventive maintenance procedures in manufacturing.

## I. COURSE OUTCOMES

**At the end of the course the students are able to:**

1. **Apply** to plan schedule and control of flexible manufacturing system.
2. **Understand** the FMS components and layouts and plan for FMS layouts.
3. **Identify the problems encountered and problem solving**.
4. **Apply** the different modules in FMS software and gain knowledge of interfacing mechanical setup electrical drives.

## II. HOW PROGRAM OUTCOMES ARE ASSESSED

| Program Outcomes | | Level | Proficiency assessed by |
|---|---|---|---|
| PO1 | **Engineering Knowledge:** Capability to apply knowledge of Mathematics, Science Engineering in the field of Mechanical Engineering | H | Seminar |
| PO2 | **Problem Analysis:** An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of Mathematics, Science and Engineering. | H | Seminar |
| PO3 | **Design/ Development of solution:** Competence to design a system, component or process to meet societal needs within realistic | S | Projects |
| PO4 | **Conduct investigation of complex problems:** To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies. | S | Projects |
| PO5 | **Modern Tool usage:** An ability to formulate solve complex engineering problems using modern engineering and information technology tools. | S | Projects |
| PO6 | **The Engineer society:** To utilize the engineering practices, techniques, skills to meet needs of health, safety legal, cultural and societal issues. | N | -- |
| PO7 | **Environment and Sustainability:** To understand the impact of engineering solution in the societal context and demonstrate the knowledge for sustainable development. | N | -- |
| PO8 | **Ethics:** An understanding and implementation of professional and Ethical responsibilities. | N | -- |
| PO9 | **Individual Team work:** To function as an effective individual and as a member or leader in multi-disciplinary environment and adopt in diverse | N | -- |
| PO10 | **Communication:** An ability to assimilate, comprehends, communicate, give and receive instructions to present effectively with engineering community and society. | N | -- |

| Program Outcomes | | Level | Proficiency assessed by |
|---|---|---|---|
| PO11 | **Project Management and Finance:** An ability to provide leadership in managing complex engineering project at multi-disciplinary environment and to become a professional engineer. | N | -- |
| PO12 | **Life-Long learning:** Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes. | S | Projects |

## III. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

| Program Specific Outcomes | | Level | Proficiency assessed by |
|---|---|---|---|
| PSO1 | **Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical system including allied engineering streams. | H | Lectures, Seminars |
| PSO2 | **Design/ Analysis:** An ability to adapt and integrate current technologies in the design and manufacturing domain to enhance the employability. | S | Projects |
| PSO3 | **Successful Career and Entrepreneurship:** To build the nation by imparting technological inputs and managerial skills to become a Technocrats. | S | Guest Lectures |

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

## IV. SYLLABUS

UNIT – I FLEXIBLE MANUFACTURING SYSTEM

Introduction: Definitions of manufacturing with input-output model, definition of system, basic problems concerning systems and system design procedure, modes of manufacturing – job/batch/flow and multi- product, small batch manufacturing.

UNIT – II SYSTEM MODELLING ISSUES

System modeling issues: Centralized versus distributed control; Real-time vs discrete event control; Forward vs. backward scheduling approaches with finite/infinite capacity loading; Modeling of absorbing states and deadlocks; Conflicts; Concurrency, and synchronization.

UNIT – III SYSTEM MODELLING TOOLS AND TECHNIQUES

System Modeling Tools and Techniques: Introduction to mathematical modeling, optimization, and simulation; issues related with deterministic and stochastic models.

Continuous and discrete mathematical modeling methods -discrete event, monte carlo method; Basic concepts of Markov chains and processes; The M/M/1 and M/M/m queue; Models of manufacturing systems including transfer lines and flexible manufacturing systems, introduction to Petri nets.

UNIT – IV PERFORMANCE ANALYSIS

Performance Analysis: Transient analysis of manufacturing systems, analysis.

UNIT – V PREVENTATIVE MATAINANCE

Preventive maintenance, Karban system, implementation issues.

TEXT BOOKS

1. N. K. Jha, "Hand Book of Flexible Manufacturing Systems", Academic Press, 1st Edition, 2013.
2. Talichi Ohno, "Production System beyond Large Scale Production", Toyota Productivity Press India Pvt. Ltd, 1st Edition, 2010.
3. H K Shivanand, "Flexible Manufacturing Systems", New Age International, 1st Edition, 2006.

REFERENCE BOOKS

1. Farid Amirouche, "Principles of Computer-Aided Design and Manufacturing, 2nd Edition, 2004.
2. P. Radha Krishnan, "CAD/ CAM/ CIM", New Age International, 4th Edition, 2016.

## COURSE PLAN

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

| Lecture No. | Course learning outcomes | Topics to be covered | Reference |
|---|---|---|---|
| 1 – 3 | **Understand** the basic concepts of FMS | Introduction: Definitions of manufacturing with input-output model, definition of system, basic problems concerning systems. | T1,T2, R1 |
| 4 – 6 | **Apply** the concept of system design procedures to different levels of production. | system design procedure, modes of manufacturing– job/batch/flow and multi-product, small batch manufacturing | T1,T2 |
| 7 – 9 | **Identify** the system modeling issues and control them | System modeling issues: Centralized versus distributed control; Real-time vs discrete event control. | T2,T3 |
| 10 – 13 | **Apply** the concept of scheduling | Forward vs. backward scheduling approaches with finite/infinite capacity loading; Modeling of absorbing states and deadlocks; Conflicts; Concurrency, and synchronization. | T1,T2 |
| 14 – 16 | **Understand and Apply** system modeling techniques | System Modeling Tools and Techniques: Introduction to mathematical modeling, optimization, and simulation; issues related with deterministic and stochastic models. | T1, R1 |
| 17 – 20 | **Distinguish** between continuous and discrete modeling techniques | Continuous and discrete mathematical modeling methods -discrete event, monte carlo method; Basic concepts of Markov chains and processes; The M/M/1 and M/M/m queue. | T1 |
| 21 – 22 | **Design** models of manufacturing systems | Models of manufacturing systems including transfer lines and flexible manufacturing systems, introduction to Petri nets. | T1 |
| 23 – 25 | **Analysis** of performance of manufacturing system | Performance Analysis: Transient analysis of manufacturing systems, analysis. | T1,T2 |
| 29 – 35 | Understand the preventative maintenance | Preventive maintenance, Karban system, implementation issues. | T1,T2 |

## XI MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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

**S - Supportive** **H - Highly related**

## XII MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

| Course Objectives | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| 1 | H | | | S | | | | | | | | | H | S | |
| 2 | S | H | S | | | | | | | | | S | H | | S |
| 3 | S | H | | | S | | | | | | | | S | | |
| 4 | H | | | S | | | | | | | | S | S | S | |
| 5 | S | H | S | | S | | | | | | | S | H | | S |
| 6 | H | S | | S | | | | | | | | | S | | |
| 7 | H | | | | S | | | | | | | S | H | S | |
| 8 | H | | | S | | | | | | | | | H | S | |
| 9 | S | H | S | | | | | | | | | S | H | | S |

**S - Supportive** **H - Highly related**

**Prepared by:** G. Naveen Kumar, Associate Professor

**HOD, ME**