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B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
CONTROL ENGINEERING

Course Code	18ME71	CIE Marks	40
Teaching Hours / Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To develop comprehensive knowledge and understanding of modern control theory, industrial automation, and systems analysis.
- To model mechanical, hydraulic, pneumatic and electrical systems.
- To represent system elements by blocks and its reduction techniques.
- To understand transient and steady state response analysis of a system.
- To carry out frequency response analysis using polar plot, Bode plot.
- To analyse a system using root locus plots.
- To study different system compensators and characteristics of linear systems.

Module-1

Introduction: Components of a control system, Open loop and closed loop systems.
Types of controllers: Proportional, Integral, Differential, Proportional-Integral, and Proportional- Integral-Differential controllers.
Modeling of Physical Systems: Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic Systems.

Module-2

Time domain performance of control systems: Typical test signal, Unit step response and time domain specifications of first order, second order system. Steady state error, error constants.

Module-3

Block diagram algebra, Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations.

Module-4

Stability of linear control systems: Routh's criterion, Root locus, Determination of phase margin and gain using root locus.

Module-5

Frequency analysis using Polar plot, Nyquist plot, Bode plot, Determination of phase margin and gain margin using Nyquist plot.

Assignment:

1. Study of On-Off Controller for Flow/ Temperature.
2. Study of Control Modes like P, PD, PI, PID for Pressure / Temperature / Flow.
3. Assignment on Root Locus, Bode Plots and Polar Plots.
4. Study of Software 'MATLAB' on the above topics.

Course Outcomes: At the end of the course, the student will be able to:

- Identify the type of control and control actions.
- Develop the mathematical model of the physical systems.
- Estimate the response and error in response of first and second order systems subjected standard input signals.
- Represent the complex physical system using block diagram and signal flow graph and obtain transfer function.
- Analyse a linear feedback control system for stability using Hurwitz criterion, Routh's criterion and root Locus technique in complex domain.

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Analyse the stability of linear feedback control systems in frequency domain using polar plots, Nyquist and Bode plots.
paper pattern: question paper will have ten full questions carrying equal marks. ch full question will be for 20 marks. re will be two full questions (with a maximum of four sub- questions) from each module. full question will have sub- question covering all the topics under a module. students will have to answer five full questions, selecting one full question from each module.

Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
k/s			
Automatic Control Systems	Farid G., Kuo B. C	McGraw Hill Education	10th Edition,2018
Control systems	Manik D. N	Cengage	2017
Books			
Modern control Engineering	K. Ogeta	Pearson	5th Edition, 2010
Control Systems Engineering	Norman S Nice		Fourth Edition, 2007
Modern control Systems	Richard C Dorf	Pearson	2017
Control Systems Engineering	IjNagrath, M Gopal	New Age International (P) Ltd	2018
Control Systems Engineering	S Palani	Tata McGraw Hill Publishing Co Ltd	ISBN-13 978007067193

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

COMPUTER AIDED DESIGN AND MANUFACTURING

ode	18ME72	CIE Marks	40
g Hours /Week (L:T:P)	3:0:0	SEE Marks	60
	03	Exam Hours	03

earning Objectives:

- To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
- To make students to understand the Computer Applications in Design and Manufacturing [CAD / AM) leading to Computer integrated systems. Enable them to perform various transformations of ntities on display devices.
- To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
- To expose students to computer aided process planning, material requirement planning, capacity planning etc.
- To expose the students to CNC Machine Tools, CNC part programming, and industrial robots.
- To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.

-1

ction to **CIM and Automation:** Automation in Production Systems, automated manufacturing types of automation, reasons for automating, Computer Integrated Manufacturing, computerized ts of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, on capacity, utilization and availability, manufacturing lead time, work-in- process, numerical s.

ted **Production Lines and Assembly Systems:** Fundamentals, system configurations, applications, ed flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow hout storage, partial automation, analysis of automated flow lines with storage buffer, ntals of automated assembly systems, numericals.

-2

Computer Graphics Software: The design process, applications of computers in design, software tion, functions of graphics package, constructing the geometry.

mations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, tation, numerical problems on transformations.

erized **Manufacture Planning and Control System:** Computer Aided Process Planning, Retrieval and e Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC computer integrated production management system, Material Requirement Planning, inputs to tem, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, r control

3

Manufacturing Systems: Fundamentals of Group Technology and Flexible Manufacturing Systems, FMS, FMS components, Material handling and storage system, applications, benefits, computer ystems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and c parts identification systems and data capture.

ncing: Line balancing algorithms, methods of line balancing, numerical problems on largest rule, Kilbridge and Wester method, and Ranked Positional Weights method, Mixed Model line

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...computerized line balancing methods.

...Numerical **Control:** Introduction, components of CNC, CNC programming, manual part ...ming, G Codes, M Codes, programming of simple components in turning, drilling and milling ...s, programming with canned cycles. Cutter radius compensations.

...echnology: Robot anatomy, joints and links, common robot configurations, robot control systems, ...and repeatability, end effectors, sensors in robotics. Robot programming methods: on-line and off-...ods. Robot industrial applications: material handling, processing and assembly and inspection.

...Manufacturing **Systems:** Basic principles of additive manufacturing, slicing CAD models for AM, ...s and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, ...jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct ...eposition techniques, applications of AM.

...Automated **Factory:** Industry 4.0, functions, applications and benefits. Components of Industry ...net of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT ...manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain ...ion, supply-chain & logistics, cyber-physical manufacturing systems.

...utcomes: At the end of the course, the student will be able to:

...ne Automation, CIM, CAD, CAM and explain the differences between these concepts. Solve ...ple problems of transformations of entities on computer screen

...lain the basics of automated manufacturing industries through mathematical models and analyze ...rent types of automated flow lines.

...lyse the automated flow linestoreduce time and enhance productivity.

...plain the use of different computer applications in manufacturing, and able to prepare part ...

...mple jobs on CNC machine tools and robot programming.

...alize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 ...applications of Internet of Things leading to Smart Manufacturing.

...paper pattern:

...uestion paper will have ten full questions carrying equal marks.

...full question will be for 20 marks.

...will be two full questions (with a maximum of four sub- questions) from each module.

...full question will have sub- question covering all the topics under a module.

...tudents will have to answer five full questions, selecting one full question from each module.

Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
...Automation, Production Systems ...nd Computer-Integrated ...Manufacturing	Mikell P Groover	Pearson Learning.	4th Edition,2015
...AD / CAM Principles and ...pplications	P N Rao	Tata McGraw-Hill	3rd Edition, 2015
...CAD/CAM/CIM	Dr. P. Radhakrishnan	New Age International Publishers, New Delhi.	3rd edition
...Books			
..."AD/CAM"	Ibrahim Zeid	Tata McGraw Hill.	
...Principles of Computer Integrated ...Manufacturing	S.Kant Vajpayee	, Prentice Hall of India, New Delhi.	1999

Work Systems And The Methods, Measurement And Management of Work	Groover M. P.,Pearson	Prentice Hall	Upper Saddle River, NJ, 2007.
Computer Automation in Manufacturing	Boucher, T. O., Chapman & Hall	London, UK,	1996.
Introduction to Robotics: Mechanics And Control	Craig, J. J.	Addison-Wesley Publishing Company	2nd Ed 1989.
Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition	Nicolas Windpassinger	Amazon.	
Internet of Things: A Hands-on Approach"	ArshdeepBahga and Vijay Madisetti	Universities Press	
Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing,	Ian Gibson, David W. Rosen, Brent Stucker		2nd Ed. (2015)
Understanding Additive Manufacturing	Andreas Gebhardt, Hanser Publishers		2011
Understanding Additive Manufacturing",	Andreas Gebhardt,	Hanser Publishers,	2011

B. E. MECHANICAL ENGINEERING
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SEMESTER – VII
Professional Elective 2

TOTAL QUALITY MANAGEMENT

Course Code	18ME734	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Understand various approaches to TQM
- Understand the characteristics of quality leader and his role.
- Develop feedback and suggestion systems for quality management.
- Enhance the knowledge in Tools and Techniques of quality management.

Module-1

Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.

Module-2

Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making,

Module-3

Customer Satisfaction and Customer Involvement: Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.

Module-4

Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.

Module-5

Total Productive Maintenance (TPM): Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance.
Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD.
Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Explain the various approaches of TQM
CO2: Infer the customer perception of quality
CO3: Analyse customer needs and perceptions to design feedback systems.
CO4: Apply statistical tools for continuous improvement of systems
CO5: Apply the tools and technique for effective implementation of TQM.

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Question paper pattern:

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- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Total Quality Management	Dale H. Besterfield	Pearson Education India,	Edition 03. ISBN: 8129702606,
2	Total Quality Management for Engineers	M. Zairi	Wood head Publishing	ISBN:1855730243
Reference Books				
1	Managing for Quality and Performance Excellence	James R. Evans and William M Lindsay	Cengage Learning.	9th edition
2	Four revolutions in management	Shoji Shiba, Alan Graham, David Walden	Oregon	1990
3	Organizational Excellence through TQM	H. Lal	New age Publications	2008
4	Engineering Optimization Methods and Applications	A Ravindran, K, M. Ragsdell	Willey India Private Limited	2nd Edition,2006
5	Introduction to Operations Research- Concepts and Cases	F.S. Hillier. G.J. Lieberman	Tata McGraw Hill	9th Edition, 2010

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SEMESTER – VII
Professional Elective 3

Course Code	**ADDITIVE MANUFACTURING**		
Teaching Hours /Week (L:T:P)	**18ME741**	CIE Marks	40
Credits	3:0:0	SEE Marks	60
	03	Exam Hours	03

Course Learning Objectives:

- To know the principle methods, areas of usage, possibilities and limitations of the Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.
- To know the principles of polymerization and powder metallurgy process, extrusion-based system printing processes, sheet lamination processes, beam deposition processes, direct write technologies and Direct Digital Manufacturing.
- To get exposed to process selection, software issues and post processing.

Module-1

Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereoli tho graphy or 3dprinting, rapid proto typing ,the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology.
Development of Additive Manufacturing Technology: Introduction, computers, computer-aidedde sign technology ,other associated technologies, the use of layers, classification of AM processes, metals ystems, hybrid systems, milestones in AM development.
Additive Manufacturing Process chain: Introduction, the eight steps in additive manufacture, variations from one AM machine to another ,metal systems, maintenance of equipment, materials handling issues, design for AM, and application areas.

Module-2

Photo polymerization processes: Stereolitho graphy (SL), Materials, SL resin curing process, Micro-stereoli thography, Process Benefits and Drawbacks, Applications of Photo polymerization Processes.
Powder bedfusion processes: Introduction, Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.
Extrusion-based systems: Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.

Module-3

Printing Processes: evolution of printing as an additive manufacturing process, research achievements in printing deposition, technical challenges of printing, printing process modeling, material modification methods, three-dimensional printing, advantages of binder printing
Sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.
Beam Deposition Processes: introduction, general beam deposition process, description material delivery, BD systems , process parameters, typical materials and microstructure, processing–structure–properties relationships, BD benefits and drawbacks.
Direct Write Technologies: Background ,ink -basedDW,laser transfer, DW thermals pray,DW beam deposition,DW liquid-phase directde position.

Module-4

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Guidelines for Process Selection: Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control.
Software issues for Additive Manufacturing: Introduction, preparation of cad models – the STL file, problems with STL files, STL file manipulation.
Post- Processing: Support material removal, surface texture improvements, preparation for use as a pattern, property enhancements using non-thermal techniques and thermal techniques.

Module-5

The use of multiple materials in additive manufacturing: Introduction, multiple material approaches, discrete multiple material processes, porous multiple material processes, blended multiple material processes, commercial applications using multiple materials, future directions.
AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application: Examples for Aerospace, defense, automobile, Bio-medical and general engineering industries.
Direct digital manufacturing: Align Technology, siemens and phonak, DDM drivers, manufacturing vs. prototyping, life- cycle costing, future of direct digital manufacturing.

Course Outcomes: At the end of the course the student will be able to:

CO1: Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
CO2: Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
CO3: Understand the various software tools, processes and techniques that enable advanced/additive manufacturing.
CO4: Apply the concepts of additive manufacturing to design and create components that satisfy product development/prototyping requirements, using advanced/additive manufacturing devices and processes.
CO6: Understand characterization techniques in additive manufacturing.
CO7: Understand the latest trends and business opportunities in additive manufacturing.

Question paper pattern:

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Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing	I. Gibson I D. W. Rosen I B. Stucker	Springer New York Heidelberg Dordrecht, London	ISBN: 978-1-4419-1119-3 e-ISBN: 978-1-4419-1120-9 DOI 10.1007/978-1-4419-1120-9
Reference Books				
1	"Rapid Prototyping: Principles & Applications	Chua Chee Kai, Leong Kah Fai	World Scientific	2003
2	Rapid Prototyping: Theory & Practice	Ali K. Kamrani,	Springer	2006

		EmandAbouel Nasr,		
3	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling"	D.T. Pham, S.S. Dimov	Springer	2001
4	Rapid Prototyping: Principles and Applications in Manufacturing	RafiqNooran	John Wiley & Sons	2006
5	Additive Manufacturing Technology	Hari Prasad, A.V.Suresh	Cengage	2019
6	Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing	Andreas Gebhardt	Hanser Publishers	2011