Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	ME601	**Title of the Course**	ADVANCED MANUFACTURING PROCESSES	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	1. In this course study of the fundamentals and advanced techniques related to manufacturing processes is done. 2. In addition to the applied aspects of manufacturing processes, a sound analytical basis for some of the processes will be taught. 3. Through the use of analytical approaches in conjunction with case studies based practical's, learning of how to control amanufacturing process for optimal production will be done. 4. This course builds a foundation of capability for the solution, analysis and synthesis of a wide variety of manufacturing problems.						

Course Outcomes	
CO1	Basics, knowledge, need and differentiation between convention and unconventional machining process
CO2	Construction, process parameters and economic aspects of ECM and Abrasive Jet machine(s).
CO3	Design the components, process parameters, MRR, surface finish and the economic consideration of EDM, EBM process.
CO4	Design the components, process parameters, MRR, surface finish and the economic consideration of LBM, PAM process. Develop knowledge on various advanced hybrid processes in manufacturing industry
CO5	To explain the processes involved in high energy metal forming mechanics and welding related activities.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Machining processes	Classification of advanced machining processes; consideration in process selection. Mechanical Metal Removal Process: Ultrasonic machining; elements of the process; mechanics of metal removal; tool designeconomic consideration; applications and limitations.	8	CO1
2	Abrasive Jet and Abrasive Water Jet Machining	Basic principles; mechanism of metal removal; variables governing the processes; design of nozzles; applications. Electro-chemical Process: Fundamentals of the ECM and ECG techniques; mechanism of metal removal; design of tooling; choice of process parameters; surface finish and accuracy; economic aspects of ECM; electro-chemical deburring; and honing.	8	CO2
3	Thermal Metal Removal Processes	Classification; general principles and applications of EDM, EBM. PAM and LBM, power circuits of EDM; mechanism of metal removal EDM; selection of EDM pulse generator, tool electrode and dielectric; machining accuracy, surface finish and surface damage in EDM; process parameters, wire EDM. Generation and control of electron beam for machining; applications; advantages and limitations.	8	CO3
4	Generation and application of plasma for metal cutting	Generation and application of plasma for metal cutting; plasma torches. Basics of laser beam machining; thermal phenomenon due to laser work surface interaction; cutting speeds and accuracy of cut; applications and limitations. Improving the efficiency of laser machining process. Process details of ion beam machining and its applications. Introduction to hybrid unconventional machining processing. ECDM, ECAM, Abrasive EDM, etc.	8	CO4
5	Metal Forming	Theory and application of Contour roll forming, stretch forming explosive forming etc. Welding:Theory and applications of electron beam welding, Laser beam welding, Ultrasonic welding, Solid state diffusion andexplosive welding process.	8	CO5

Reference Books:

Non Traditional Machining Processes Springborn: ASTME Michigam

Modern Machining Processes: Pandey and Shan, THM

Electrochemical Machining: De Bar, Mc Donald

Metals Handbook Forming: -

Advance Machining Processes : Jain, Allied Publishers.

e-Learning Source:

https://www.youtube.com/watch?v=oI3RIAvyVxc&list=PLbMVogVj5nJSzoQXmu7dsj9ZKJyZ1P4O8

https://www.youtube.com/watch?v=t7yv4gSnNkE&list=PLwdnzlV3ogoWI8QEu4hsT-n_r8UbWbquy

https://www.youtube.com/watch?v=1MkWjVjNFhY&list=PLYY-vaDZXAyxyB8EY_-4FYfAXfHeNY0Li

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO															
CO1	**3**	**3**	**3**	**2**	**3**	**3**	**1**				**3**	**3**	3		
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**1**				**3**	**3**	3	1	1
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**1**				**3**	**3**	2	2	1
CO4	**3**	**2**	**3**	**2**	**3**	**3**	**1**				**3**	**3**	3	3	3
CO5	**3**	**1**	**1**	**1**	**1**	**3**	**1**				**3**	**3**	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	ME602	**Title of the Course**	**FLEXIBLE MANUFACTURING SYSTEM**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives							

Course Outcomes	
CO1	To introduce and discuss flexible manufacturing concepts
CO2	To have the students gain insight about the state-of-the-art research areas related to FMS and real-time shop floor control
CO3	Be able to plan, setup and understand the concepts and applications of flexible manufacturing tools.
CO4	Enhance the ability of group technology and to analyze and calculate the production capacity using mathematical and computer programming.
CO5	Ability to perform Planning, Scheduling and control of Flexible Manufacturing systems

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction:**	Concepts of flexibilities and its importance in batch manufacturing Various type of FMS configurations, their planning and control. FMS definition and Classification of manufacturing systems Fundamentals of automated Production Cycle, Need of Flexibility, Concept of Flexibility, various Types of Flexibility and Measures of Flexibility.	8	CO1
2	**FMS Equipment:**	FMS and its importance, Factors responsible for the growth of the FMS, FMS types, Application of FMS, Economic Justification for FMS and FMC Functional requirements of FMS equipment, FMS processing and Q.A. Equipment e.g. turning and machining centers,	8	CO2
3		Co-ordinate measuring machines, cleaning and deburring machines. FMS system support equipment: automated material handling and storage equipment, cutting tools and tools management, work-holding considerations, fixture consideration in FMS environment.	8	CO3
4	**Group Technology and FMS:**	GT concepts, advantages of GT, part family formation-coding and classifications systems; Part-machine group analysis; methods for cell formation, model of different algorithms, mathematical programming and graph theoretic model approach for part grouping, cellular production	8	CO4
5		FMS planning problems: Strategic planning, part type, selection, machine grouping, production ratio and resource allocation, machine loading problems. Operational & Controls problems: Scheduling of parts, machines, robots and AGVS. Process monitoring and control. FMS Implementation: Objectives, Acceptance Testing Performance Goals and Expectations, Maintenance Concerns.	8	CO5

Reference Books:

Automation, Production System and CAM : Grover, Englewood

Design and Operation of FMS: Rankey, IFS

Flexible Manufacturing System: Wernecks, Springer-Gerlag

FMS in Practice: Bonctto, Northox Ford

Flexible Manufacturing Cells and System: W.W. Luggen, Prentice Hall

Performance Modeling of Automated Manufacturing System: ViswanathanNarahari, Prentice Hall.

Flexible Manufacturing Systems in Practice: Talavage and Hamman

e-Learning Source:

http://engineeringstudymaterial.net/ebook/flexible-manufacturing-system

http://www.sciencedirect.com/science/book/978012385310

http://www.ignou.ac.in/upload/UNIT6-55.pdf

http://www.journals.elsevier.com/computer-aided-design

https://www.elsevier.com/books/surface-modeling-for-cad-cam/choi/978-0-444-88482-4

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1		1	1	1		1		1		3	1	1
CO2	3	3	1		1	2	1		1		1		3	2	1
CO3	3	3	3	2	3	1	1		3		3	1	3	3	1
CO4	3	3	3	1	3	3	1		3		3	1	3	3	1
CO5	3	3	1		3	1	1		3		3	1	3	3	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	ME603	**Title of the Course**	Advance Welding Technology	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives							

Course Outcomes	
CO1	Apply the knowledge of welding process for engineering applications
CO2	Understand the principles of various advance welding technologies used for metal joining process
CO3	Analyze and inspect the weld joint strength and defects
CO4	Understand the fundamentals of welding of different materials and able to train others in use of welding.
CO5	Understand the knowledge of design principles in weld joints and the thermal analysis of weld joint also apply the concept of quality control and testing of weldments in industrial environment

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction** **Physics of Welding Arc**	Welding as compared with other fabrication processes, Classification and review ofconventional Welding Processes. Welding arc, arc initiation and maintenance voltage distribution along the arc, cathode and anode drops, Arc column. Characteristics of welding power sources, arc characteristics, arc efficiency, heat generation at cathode and anode Effect of shielding gas on metal transfer, isotherms of arcs.	8	CO1
2	**Metal Transfer**	Mechanism and types of metal transfer in various arc welding processes, arc length regulation inmechanized welding processes, Transformer, rectifier and generators, Duty cycle and power factor, Static and dynamic characteristics of welding power sources.	8	CO2
3	**Welding Processes**	Critical review and analysis of MMA; TIG MIG and C02 welding processes plasma arc, submergedarc welding, electro-gas and electro-slag welding; resistance welding. Theory and mechanism of solid state welding; technique and scope of friction welding, diffusion welding; cold pressure welding and ultrasonic welding, scope and application of electron beam and laser beam welding processes	8	CO3
4	**Heat Flow in Welding**	Analysis of Heat transfer and temperature distribution in electric arc welding; width of Heat Affected Zone; cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention.	8	CO4
5	**Weldability of Metals.**	Effects of alloying elements on weldability, welding of plain carbon steel, stainless steel, CastIron and aluminum. Evaluation of weldability. Testing and inspection of welds. Welding of PVC plastics. Welding under the influence of Magnetic field.	8	CO5

Reference Books:

Welding Handbook-AWS, Vol. 1-5

Welding Science and Technology-M.I. Khan, New-Age International.

Welding For Engineer. Udin, Fruk andWulif, John Wiley.

Welding Technology, Rossi, McGraw Hill.

e-Learning Source:

https://www.youtube.com/watch?v=cQEUJnMYf_U&list=PLwdnzlV3ogoUQnGO8eFFvgVBTjF0xyYMq

https://www.youtube.com/watch?v=ow9OrL5T8qQ&list=PLFFMIXoXGiOXW1XVYyfvf9uTdDXwDPylh

https://www.youtube.com/watch?v=AvXoEp53zAY&list=PLSGws_74K019IqR1NmlxuhvKYq1IjuCXW

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	3	-	-	-	-	-	3	3	2	2
CO2	3	3	3	2	1	1	-	-	-	-	-	2	3	2	2
CO3	3	2	1	1	2	2	3	-	-	-	-	3	3	3	2
CO4	3	2	2	2	3	3	-	-	-	-	-	2	3	2	3
CO5															

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2017-2018							
Course Code	ME604	**Title of the Course**	ADVANCED METAL CASTING TECHNOLOGY	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	To learn various concepts related to casting. To have practical purview of various special casting techniques. To Analyze and access the use of casting processes in manufacturing and measures & inspect the defects with use of advance technology.						

Course Outcomes	
CO1	Learn to identify casting problems and solidification & pattern design developments processes.
CO2	Learn & Understand Risering & Gating systems.
CO3	Learn molding & core making processes
CO4	Learn Selection and control of melting furnaces, Fluidity and residual stresses.
CO5	Learn inspection & quality control in casting & foundry practice. Use of computer in foundry.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1		**Introduction:** The features of casting problem; a survey and scope of foundry industry. **Solidification:** Solidification of pure metals and alloys; nucleation and growth in alloys; solidification of actual castings; progressive and directional solidification; centerline feeding resistance; rate of solidification; Chvorinov's Rule, electrical analog of solidification problem. **Patterns :** Pattern design; developments in pattern design; materials and construction.	8	CO1
2		**Risering :** Riser design; risering curves; method of riser design; feeding distance; risering of complex casting; risering of alloys other than steel; recent developments e.g. riser design by the application of geometrical programming. **Gating :** Gating systems and their characteristics; the effect of gates on aspiration; turbulence and dross trap; recent trends.	8	CO2
3		**Molding and Core Making processes:** Review and critical comparison of various established processes; recent developments eg. Low pressure and ferrous die casting; high pressure molding; full mold process; flaskless-molding, hot and coldboxmolding; ceramic shell **molding;** V-preocess; continous casting squeeze and pressed casting; New moulding and core making process.	8	CO3
4		**Melting:** Selection and control of melting furnaces; melting, refining and pouring; recent trends: cupola design. **Fluidity:** Measurement of fluidity; effects of various parameters on fluidity. Internal Stress, Defects and Surface Finish: **Residual stresses**; hot tears and cracks in castings; stress relief; defects causes and remedies; various parameters affecting surface finish and related defects e.g. rough casting, sand bum-on sand bum-in and metal penetration; facting and washes; mold wall movement; vapor transport zones; expansion scabbing etc.	8	CO4
5		**Gases in Metal:** Methods of elimination and control of dissolved gases in castings. Foundry Practice:	8	CO5

		Casting of different types of cast irons; aluminum; zinc; brass etc; mechanization in factory; use of computer in foundry. **Inspection and Quality Control:** Review of x-ray radiography; magnetic particle; penetrant and ultrasonic inspections; use of statistical quality control in foundry.		

Reference Books:

1. Metal Casting Computer Aided Design and Analysis: Ravi B. Prentice Hall of India.
2. Fundamentals of Metal Casting: Flinn, R.A., Addison-wesley Reading, Massachusetts, 1963.
3. Transport Phenomena in Metallurgy: Geiger. G.H. and Poirier, D.R. Addison Wesley, Reading.
4. Thermodynamics for the Foundaryaman: Veynik, A.I. Mac Laren, London, 1968.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	2		3						2	2	2	3			
CO2	2	3	3	2	2	3						3	2	3	2			
CO3	3	3	3	3	2	3						1	3	2	3			
CO4	3	3	3	2		3						2	3	3	2			
CO5	1	1	1	1		2						2	1	2	3			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	ME605	**Title of the Course**	Friction & Wear	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	**1.** To impart knowledge about the significance of wear of newly developed engineering materials used in industries and research organizations for elastic and plastic deformations 2. To inculcate specialized knowledge and skill in designing of various components used in mechanical engineering.. 3. To cultivate the ability to develop and implement new and improved component. **4.** To impart knowledge about Friction and Engineering Materials, Wear and its Mechanisms.						

Course Outcomes	
CO1	Fundamental concepts and importance of Concept of a surface and surface topography of engineering surfaces
CO2	Fundamental concepts and importance of Friction and Engineering Materials.
CO3	Fundamental concepts and importance of Assessment and Control of Friction.
CO4	Fundamental concepts of Wear and its Mechanisms.
CO5	Fundamental concepts and importance of Wear Estimation , Control & Lubrication.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Concept of a surface and surface topography of engineering surfaces; Interaction between contacting surfaces, concept of elasticand plastic deformation, Hertz's contact theory; Concept of surface forces electrostatic forces, capillary forces and van der Waal forces.	8	CO1
2	Friction and Engineering Materials	Concept and laws of friction; Theories of friction, rolling friction, sliding friction, Coulomb model, junction growth, asperity deformation, stresses in friction; Temperature in friction. Friction of metallic materials, ceramics, polymers and lamellar solids.	8	CO2
3	Assessment and Control of Friction	Assessment of co-efficient of friction, measurement of friction force and contact temperature, assessmentof surface forces, tribometer and atomic force microscope (AFM); Lubricants in reducing friction.	8	CO3
4	Wear and its Mechanisms	Concept of wear of engineering surfaces; Types of wear; Sliding wear, dry and lubricated wear of surfaces, chemical wear. Abrasion; Adhesion; Erosion; Fatigue; Corrosion ,Other forms of wear. Wear Characteristics of Engineering Materials: Wear of metallic materials, ceramics, composites and polymers.	8	CO4
5	Wear estimation and Control	ASTM standards for estimation of wear of engineering surfaces, Modification of functional surfaces for minimization of wear, selection of materials and techniques.	8	CO5

Reference Books:

1. Rabinowicz, E., "Friction and Wear of Materials", John Wiley and Sons, Inc., New York. 1965
2. Hutchings, I.M., "Tribology: Friction and Wear of Engineering Materials", Edward Arnold, London.1992
3. Rigney, D.A.(ed.), "Fundamentals of Friction and Wear of Materials", American Society for Metals, Ohio, USA. 1981
4. ZumGahr, K. H., "Microstructure and Wear of Materials", Elsevier, Amsterdam. 1987
5. Burnell-Gray, J. S. and Datta, P.K. (eds.), "Surface Engineering Casebook", Woodhead Publishing Limited, Cambridge, England.1996
6. Dowson, D., "History of Tribology", Longman, London. 1978
7. Bowden, F. P. and Tabor, D., "The Friction and Lubrication of Solids", Part I & II, Clarendon Press, Oxford. 1964
8. Takadoum, J., "Materials and Surface Engineering in Tribology", John Wiley and Sons, Inc., London. 2008

e-Learning Source:

https://www.youtube.com/watch?v=Bmj85Ihfv7w&list=PLLy_2iUCG87Bhld-RXqBIAwKCLaLjOzX_

https://www.youtube.com/watch?v=4zFrTHk2X3s

https://www.youtube.com/watch?v=ZOEWEwxiNUU

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	1	1	1	3	2	3	3	2	2
CO2	3	3	3	2	3	3	1					2	3	3	2
CO3	3	2	2	2	2	3	2	3	2	1	3	2	3	2	2
CO4	3	2	2	2	3	3						2	3	2	2

CO5	3	1	1	1	1	3						2	3	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	ME606	**Title of the Course**	**DESIGN FOR MANUFACTURE**	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	• Understanding the basic design rules for manufacturing and material selection. • Applying the production process for ease of manufacturing. • Analyze factors for selection of metals and alloys and relationship to manufacturing processes • Apply the concepts of design for manufacturing and assembly for product manufacturing. • Compare various manufacturing processes and assembly techniques required for product development.						

Course Outcomes	
CO1	Understand to relate design rules for manufacturability
CO2	Remember the basic principles of designing for economical production-creativity in design
CO3	Understand the principles of selection of materials for product development
CO4	Apply design rules for ease of manufacturing
CO5	Understand the various advantages and limitations of manufacturing

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction	Introduction, concept of concurrent engineering, need of concurrent engineering, Automation of design and manufacturing functions in CIM, computer aided process planning, Design for Manufacture , Approaches to DFM & DFM, Design for Automated Manufacturing and Design for Economic Manufacturing.	8	CO1
2	Design Quality	Quality by Design, QFD, Taguchi's concept of Quality Loss function parameter design, comparing alternative design, tolerance design, system optimization, Robust design.	8	CO2
3	Design for Reliability	Basic concepts, reliability analysis during design phase, failure mode analysis, reliability analysis of mechanical systems, design guidelines for reliability, maintainability and testability, reliability tests, quality reliability assurance during production phase.	8	CO3
4	Design Knowledge Representation	Design for manufacturing and re-design considerations in automated CAD/CAM systems, Design and manufacturing knowledge representation, knowledge representation for DFM support, intelligent evaluation of design for manufacturing cost.	8	CO4
5	Evaluation of Manufacturability	Evaluation of the manufacturability of a part design, various methods of defining manufacturability index, interpretation of the MI value, Manufacturability evaluation; a multi criteria approach	8	CO5

Reference Books:

Integrated Product Development : M.M. Andersen and L. Mein, IFS Pub.

Product Design for manufacture: G Boothroyd, P Dewhurst and W. Knight, Marcel Dekker

Handbook of Product Design for Manufacture, A practical Guide to low Cost Production: J. G. Bralla, McGraw Hill

G.D. Huang, Chapman & Hall

Concurrent Engineering: Kusiak, Wiley

Competitive Product Design for Manufacturability: Barkan and IshuiMcMillon.

e-Learning Source:

https://www.youtube.com/watch?v=vEPpKjIdpt0&list=PLyqSpQzTE6M_1kARI-8O0ZJjTwD9bAsRe

https://www.youtube.com/watch?v=V5NMJywHS9M

https://www.youtube.com/watch?v=0TQCjgE4a6s&list=PLIUcchh5zvdUK41GRxWC3eAUmzQHa87xG

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4
CO1	3	3	2	2		3						2	2	2	3
CO2	2	3	3	2	2	3						3	2	3	2
CO3	3	3	3	3	2	3						1	3	2	3
CO4	3	3	3	2		3						2	3	3	2
CO5	1	1	1	1		2						2	1	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: : 2017-18							
Course Code	ME607	**Title of the Course**	OPTIMIZATION TECHNIQUES IN ENGINEERING	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	Operation research models using optimization techniques based upon the fundamentals of engineering mathematics (minimization and Maximization of objective function).						

Course Outcomes	
CO1	Study the concepts of relation, function, discrete numeric function, and algebraic structure.
CO2	Understand and develop the logical skills and study the concept of lattices.
CO3	Study the concepts of formal language
CO4	Develop the concepts construct finite automata with regular expression.
CO5	Develop the concepts to design the Turing/Pushdown automata machine.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Unconstrained Optimization**	Unconstrained Optimization: Optimizing Single-Variable Functions, conditions for Local Minimum and Maximum, Optimizing Multi-Variable Functions. Constrained Optimization: Optimizing Multivariable Functions with Equality Constraint: Direct Search Method, Lagrange Multipliers Method.	8	CO1
2	**Constrained Optimization**	Constrained Optimization: Constrained Multivariable Optimization with inequality constrained: Kuhn-Tucker Necessary conditions, Kuhn – Tucker Sufficient Conditions. Optimization: Quasi-Newton Methods and line search, least squares optimization, Gauss-Newton, Levenberg- Marquartd, Extensions of LP to Mixed Integer Linear Programming (MILP).	8	CO2
3	**Optimization**	Optimization: Non-Liner Programming, the Newton Algorithm, Non-Linear Least Squares, Sequential Quadratics Programming (SQP), Constrained Optimization, Multi-Objective Optimization, Branch and Bound Approaches, Genetic Algorithms and Genetic Programming,	8	CO3
4	**Complex Variable and Numerical Analysis**	Optimization and Functions of a Complex Variable and Numerical Analysis: The Finite Difference Method for Poisson's Equation in two Dimensions and for the Transient Heat Equation, Eulers Method, The Modified Euler Method and the Runga-Kutta Method for Ordinary Differential Equations, Gaussian Quardative Tranzoidal Rule and Simpson's 1/3 and 3/8 Rules, the Newton Raphson in one and two Dimensions	8	CO4
5	**Evolution of neural networks**	Evolution of neural networks; Artificial Neural Network: Basic model, Classification, Feed forward and Recurrent topologies, Activation functions; Learning algorithms: Supervised, Un-supervised and Reinforcement. Classical and fuzzy sets: Introduction, Operations and Properties, Fuzzy Relations: Cardinality, Operations and Properties, Equivalence and tolerance relation, Value assignment: cosine amplitude and max-min method.	8	CO5

Reference Books:

1. Winston W L: Operations Research: Applications and Algorithms
2. Rao S.S., Optimization: Theory and Applications.
3. Walsh G R: M methods of Optimization.
4. Williams H.P.: Model Building in Mathematics Programming.
5. Williams H.P.: Model Solving in Mathematics Programming
6. G.L. Nemhauser and L.A. Wolsey: Intger and Combinational Optimization.
7. R.G. Parker and R.L. Rardin:Discrete Optimization.
8. Limin Fu, "Neural Networks in Computer Intelligence," McGraw Hill, 2003.
9. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," McGraw Hill,1995.
10. B.Yegnanarayana, "Artificial Neural Networks," PHI, India, 2006.

e-Learning Source:

https://www.youtube.com/watch?v=84HOL_EiJ4M&list=PLLtQL9wSL16ioUvHckGCkoWq_CIvyUI0p

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2		3						2	2	2	3
CO2	2	3	3	2	2	3						3	2	3	2
CO3	3	3	3	3	2	3						1	3	2	3
CO4	3	3	3	2		3						2	3	3	2
CO5	1	1	1	1		2						2	1	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	ME608	**Title of the Course**	MAINTENANCE MANAGEMENT	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	1. To make students aware about different types of maintenance management systems. 2. Job allocation and man power allocation. 3. To make students capable of understanding reliability, maintainability, availability and their practical application. 4. To develop comprehension about the effect of maintenance on productivity and reliability 5. To develop comprehension about the use of computer in achieving maintenance objectives.						

Course Outcomes	
CO1	Comprehension of Policies for work allocation, interplant relations, workforce and control.
CO2	Comprehension of Maintenance Planning and Scheduling activities.
CO3	Comprehension of Total Productive Maintenance (TPM) & Maintenance budgeting and control.
CO4	Comprehension of Economical aspects of maintainability and reliability
CO5	Comprehension of computer maintenance management system (CMMS), & its Integration with overall organizations network,

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction	Importance, definition, meaning and scope of maintenance, objectives, duties, functions and responsibilities of maintenance engineering department, organization and structure of maintenance systems, types of maintenance, replacement need, case studies and simple probabilistic models for items that fail completely, crew size determination. Management Policies for Maintenance: Policies for work allocation, interplant relations, workforce and control.	8	CO1
2	Maintenance Planning and Scheduling	Maintenance planning, strategies and scheduling, reliability oriented maintenance systems, reliability programme, reliability improvement, role of reliability evaluation ,mean time to failure, quantitative estimation of reliability, failure modes effects and critically analysis (FMECA), reliability models and indices. Introducing standby unit into production system, optimum design of a series/parallel system, breakdown time distribution.	8	CO2
3	Total Productive Maintenance (TPM)	Objectives, waste elimination, equipment maintenance techniques. Benefits of TPM, pillars of TPM, performance measures of maintenance systems. Maintenance Activities: Optimal overhaul/repair or replacement, Maintenance budgeting and control, production maintenance integration. Different condition monitoring techniques like visual, performance, fluid and vibration monitoring	8	CO3
4	Maintainability and Availability	Applications of probability distributions, factors affecting maintainability, economical aspects of maintainability and reliability, maintainability increment, overall equipment effectiveness, productivity and maintenance, condition based maintenance, equipment availability, types of equipment availability, approach to increase equipment availability.	8	CO4
5	Computer Aided Maintenance	Introduction, benefits, selection process for software, use of computers in decision making for maintenance, system implementation, and key maintenance features, functions of computer maintenance management system (CMMS), Integration of CMMS with overall organizations network, Software and hardware failure, future course of CMMS.	8	CO5

Reference Books:

K. Venkataraman,"Maintenance Engineering and Management", PHI

R. C. Mishra, "Reliability and Maintenance Engineering", New Age International

R. Panneerselram, "Production and operations Management", PHI

L R Higgins, "Maintenance Engineering Handbook", Mcgraw Hill Inc

Kelly A and M J Harris, "Management of Industrial Maintenance", Butterworth & Co.

e-Learning Source:

https://www.youtube.com/watch?v=aQeu5fynOLE

https://www.youtube.com/watch?v=f58SW0Hwcf0

https://www.youtube.com/watch?v=vOykcERGw9Y&list=PLLy_2iUCG87DH0iQSVWZ8iamVl5SaLlXQ

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	3	2	2	1	1	2	2			1	1		3	1	1
CO2	3	3	3	1	2	2	2			1	1		3	1	1
CO3	3	2	3	1	2	3	2	1		1	1		3	2	1
CO4	3	2	2	1	2	2	2			1	1		3	3	1
CO5	3	3	3	2	3	2	3			1	3		2	3	1

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	ME609	**Title of the Course**	PRODUCT DESIGN AND DEVELOPMENT	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	**III**	**3**	**1**	**0**	**4**
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	1. To impart basic concepts of engineering product design and their applications. 2. To impart knowledge about idea generation and creativity used in the development of a product. 3. To let understand the use of economical aspect in product design. 4. To impart concepts related to product life cycle, reliability and ergonomics. 5. To impart basic knowledge about literature search, patents, standards and codes.						

Course Outcomes	
CO1	Explained the basic concepts of engineering product development design and their Applications. Also discussed the Design definitions, the role and nature of design, old and new design methods, Design by evolution. Physical reliability & Economic feasibility of design concepts.
CO2	Demonstrate about Product specifications, Tolerance specifications, Taguchi loss factor concepts, Quality functions deployment, Functional specifications of products, Form and function, Development of alternatives.
CO3	Demonstrate the concept of Product specifications, Tolerance specifications, Taguchi loss factor concepts, Quality functions deployment, Functional specifications of products, Form and function, Development of alternatives.
CO4	Demonstrate the concepts of Holistic product development approaches-Form product concept to decommissioning, Environment requirements, Life cycle design, Product life cycle management systems, concurrent engineering in development of products.
CO5	Explained about the Internet based approach to product development involving users. Democratization of innovation, connecting products to services, Experience innovation, robust design, Patents and Intellectual properties, product Developments.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Introduction, Sources of new ideas, Development processes, Product planning, Identification for Customer needs and technology potentials, Innovation and intellectual property rights, Product and process Patents, Patents and patenting processes.	8	CO1
2	Product specifications	Product specifications, Tolerance specifications, Taguchi loss factor concepts, Quality functions deployment, Functional specifications of products, Form and function, Development of alternatives.	8	CO2
3	Design for manufacture	Design for manufacture, Design for Assembly and design for economy, Prototyping and analytical prototyping, Stage-gate process of product development.	8	CO3
4	Product development approaches	Holistic product development approaches-Form product concept to decommissioning, Environment requirements, Life cycle design, Product data management and Product life cycle management systems, Dependency and concurrent engineering in development of products.	8	CO4
5	Internet based approach to product development	Internet based approach to product development involving users. Democratization of innovation, connecting products to services, Experience innovation, robust design, Patents and Intellectual properties, product Developments.	8	CO5

Reference Books:

1. Production Management K K Ahuja CBS Publishers
2. Production Design and Manufacturing A.K. Chitale & A.K. Gupta Prentice Hall of India
3. Management Development Alan Mumford Jaico Publishing House

e-Learning Source:

1. https://youtu.be/HN9GtL21rb4
2. https://youtu.be/ooR2HOASuvs

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	3	2	2		3						2	2	2	3	
CO2	2	3	3	2	2	3						3	2	3	2	
CO3	3	3	3	3	2	3						1	3	2	3	
CO4	3	3	3	2		3						2	3	3	2	
CO5	1	1	1	1		2						2	1	2	3	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: : 2017-18							
Course Code	ME610	**Title of the Course**	**INDUSTRIAL AUTOMATION AND ROBOTICS**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	1)To define Industrial Automation and explain its common terminology 2) To classify Manufacturing Industry and categorise them on different classes of Automation Systems 3) Explain the meaning of fluid power and list the various industrial applications of fluid power 4) List the basic components of the pneumatic systems. 5) Differentiate between electrical, pneumatic and fluid power systems.						

Course Outcomes	
CO1	Illustrate the importance and need of robotics based automation technology
CO2	Design / Simulate a robot which meets kinematic requirements.
CO3	Apply localization and mapping aspects of mobile robotics.
CO4	Explain 3D translation and orientation representation & Illustrate the robot arm kinematics and use of Robot Operating System usage
CO5	To understand robot programming

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**INTRODUCTION OF MANUFACTURING AUTOMATION**	**Introduction to Automation:** Automation production system, Mechanization and automation, Types of automation, Automation strategies, Mechanical, electrical, hydraulic and Pneumatic automation devices and controls, Economics **High Volume Manufacturing Automation:** Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multimodal and mixed model production lines.	8	CO1
2	**CNC MACHINES AND THEIR DESIGNS**	**Programmable Manufacturing Automation:** CNC machine tools, Machining centers, Programmable robots, Robot time estimation in manufacturing operations. **Flexible Manufacturing Automation:** Introduction to Group Technology, Grouping methods, Cell Design, Flexible manufacturing system.	8	CO2
3	**ROBOT SYSTEMS**	**Assembly Automation:** Assembly systems, Automatic transfer, feeding and orienting devices, Flexible assembly systems, Performance evaluation and economics of assembly systems **Robotics:** Review of robotic technology and applications, Laws of robotics, Robot systems and anatomy, Robot classification, End Effectors, Robot kinematics, Object location	8	CO3
4	**ROBOT MOTION AND ACTIVITIES**	**Robotics:** Homogeneous transformation, Direct and inverse kinematics, Manipulator motions, Robot drives, actuators and control, Drive systems, Hydraulic, Pneumatic Electrical DC and AC servo motors and stepped motors, Mechanical transmission method Rotary-to-rotary motion conversion, Robot motion and path planning control and Controllers, Robot sensing, Range sensing, Proximity sensing, touch sensing, Force and torque sensing etc., Robot vision, Image representation, Image recognition approaches	8	CO4
5	**APPLICATION OF AI SYSTEM**	**Robot Applications:** Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference, Economics and social aspects of robotics, Future applications.	8	CO5

Reference Books:

1. Automation, Production System & Computer Integrated Manufacturing Groover Prentice Hall India
2. Principles of Automation & Automated Production Process Malov and Ivanov Mir Publication
3. Automation in Production Engineering Oates and Georgy Newness -
4. Stochastic Models of Manufacturing Systems Buzacott & shanty Kumar Prentice Hall India
5. Robotics K.S. Fu, R.C. Gonzalez, C.S.G. Lee McGraw Hill
6. Robotics J.J. Craig Addison-Wesely
7. Robot Engineering: An Integrated Approach R.D. Klafter, t.a. Chmielewski and M. Negin Prentice Hall India

e-Learning Source:

https://www.youtube.com/watch?v=v-3TmN4HhLc&list=PLwdnzlV3ogoW31clPN6Dn6c8Ia-n36vXk

https://www.youtube.com/watch?v=McqDT1DMlh8&list=PLXDsvE7qtfNdt9oYEhJ_LMXDUGu6bH-L6

https://www.youtube.com/watch?v=a6_fgnuuYfE&list=PLyqSpQzTE6M_XM9cvjLLO_Azt1FkgPhpH

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2		3						2	2	2	3
CO2	2	3	3	2	2	3						3	2	3	2
CO3	3	3	3	3	2	3						1	3	2	3
CO4	3	3	3	2		3						2	3	3	2
CO5	1	1	1	1		2						2	1	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**