DR. A. P. J. ABDUL KALAM TECHNICAL UNIVERSITY

LUCKNOW, UTTAR PRADESH

STUDY & EVALUATION SCHEME WITH SYLLABUS

FOR

B. TECH. 4th YEAR

PRODUCTION ENGINEERING/
INDUSTRIAL PRODUCTION ENGINEERING

[Effective from Session: 2021-22]

B. Tech Production Engineering/ Industrial Production Engineering
Evaluation Scheme
Effective in Session 2021-22

SEMESTER- VII

Sl. No.	Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1		HSMC-1/HSMC-2	3	0	0	30	20	50		100		150	3
2		Departmental Elective-IV	3	0	0	30	20	50		100		150	3
3		Departmental Elective-V	3	0	0	30	20	50		100		150	3
4		Open Elective-II	3	0	0	30	20	50		100		150	3
5	KME 751	Measurement & Metrology Lab	0	0	2				25		25	50	1
6	KPI 751	Mini Project or Internship Assessment*	0	0	2				50			50	1
7	KPI 752	Project	0	0	8				150			150	4
8		MOOCs (Essential for Hons. Degree)											
		Total	**12**	**0**	**12**							**850**	**18**

*The Mini Project or internship (5 - 6 weeks) conducted during summer break after VI semester and will be assessed during VII semester.

SEMESTER- VIII

Sl. No.	Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1		HSMC-2/HSMC-1	3	0	0	30	20	50		100		150	3
2		Open Elective-III	3	0	0	30	20	50		100		150	3
3		Open Elective-IV	3	0	0	30	20	50		100		150	3
4	KPI 851	Project	0	0	18				100		300	400	9
5		MOOCs (Essential for Hons. Degree)											
		Total	**9**	**0**	**18**							**850**	**18**

Student can choose any elective horizontally from the pool of electives

Sem VII	**Code**	**KME 071**	**KPI 071**	**KPI 072**
	Departmental Elective-IV	Additive manufacturing	Flexible Manufacturing System	Facility Planning & Design
Sem VII	**Code**	**KME 073**	**KME 074**	**KPI 073**
	Departmental Elective-V	Mathematical Modeling of Manufacturing Processes	Machine Learning	Project Management

Subject Code: KME 751	Measurement & Metrology Lab	L T P : 0 0 2	Credits: 1

Course Outcome (CO): The Students will be able to		Bloom Taxonomy
CO-1	Understand the basic principles of instrumentation for measurement of surface finish, strain, temperature, pressure and flow.	K2
CO-2	Understand the principle and operation of Coordinate Measuring Machine (CMM).	K2
CO-3	Apply Sine Bar, Slip Gauges, Bevel Protractor, Stroboscope, Dial Indicator etc. for measurement of different attributes.	K3
CO-4	Apply the basic concepts of limits, fits & tolerances for selective assembly.	K3

List of Experiments

Minimum 08 experiments out of following (or such experiment) are to be performed:

1. Measurement of effective diameter of a screw thread using 3 wire method.
2. Measurement of angle using sine bar & slip gauges.
3. Study of limit gauges.
4. Study & angular measurement using Bevel protector.
5. Study of different types of Comparators.
6. Study of important parameters of surface finish.
7. Study of principle and operation of coordinate-measuring machine (CMM).
8. Use of dial indicator and V Block to check the circularity and plot the polar Graph.
9. Study and understanding of limits, fits & tolerances in assembly of machine components.
10. Study and understanding of different methods of measurement of pressure.
11. Study and understanding of different methods of measurement of temperature.
12. Study and understanding of measurement of strain using strain gauges.
13. Study and understanding of different methods of measurement of flow.
14. Study and understanding of different methods of measurement of vibration/power.
15. Study and understanding of measurement of displacement using LVDT.

Semester – VII: Departmental Elective – IV

Subject Code: KME 071	Additive manufacturing	L T P : 3 0 0	Credits: 3

Course Outcome: Student will be able to		Bloom Taxonomy
CO 1	Understanding the basics of additive manufacturing/rapid prototyping and its advantages and disadvantages	K2
CO 2	Understanding the role of additive manufacturing in the design process and the implications for design.	K2
CO 3	Understanding the processes used in additive manufacturing for a range of materials and applications	K2
CO 4	Understand the various software tools, processes and techniques that enable advanced/additive manufacturing and personal fabrication.	K2
CO 5	Apply knowledge of additive manufacturing for various real-life applications	K3

UNIT I

Introduction

History and Advantages of Additive Manufacturing, Distinction Between Additive Manufacturing and CNC Machining, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines, Direct and Indirect Processes; Prototyping, Manufacturing and Tooling.

Layer Manufacturing Processes: Polymerization, Sintering and Melting, Extrusion, Powder Binder Bonding, Layer Laminate Manufacturing, Other Processes; Aerosol printing and Bio plotter.

UNIT II

Development of Additive Manufacturing Technology

Computer Aided Design Technology, Other Associated Technology, Metal and Hybrid Systems.

Generalized Additive Manufacturing Process Chain; The Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Metal System, Maintenance of Equipment, Material Handling Issue, Design of AM.

UNIT III

Additive Manufacturing Processes

Vat Photo polymerization; Materials, Reaction Rates, Photo polymerization Process Modelling, Scan Patterns

Powder Bed Fusion Processes; Material, Powder Fusion Mechanism, Process Parameters and Modeling, powder Handling

Extrusion Based System; Basic principles, plotting and Path Control, Other Systems

Material Jetting; Materials, Material Processing Fundamentals, Material Jetting Machines

Directed Energy Deposition Processes; General DED Process Description, Material Delivery, DED systems, Process Parameters, Processing-Structure-Properties Relationships

UNIT IV: Design & Software Issues

Additive Manufacturing Design and Strategies; Potentials and Resulting Perspectives, AM based New Strategies, Material Design and Quality Aspects for Additive Manufacturing; Material for AM, Engineering Design Rules for AM.

Software Issue for Additive Manufacturing; Introduction, Preparation of CAD Models: The STL file, Problem with STL file, STL files Manipulation, Beyond the STL file, Additional Software to Assist AM

UNIT V

Material Design & Quality Aspects

Machines for Additive Manufacturing, Printers, Secondary Rapid Prototyping processes, Intellectual Property, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing, Business Opportunities

Applications

Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewellery, Toys, Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others.

Books and References:

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, by- Ian Gibson , DSavid W. Rosen , Brent Stucker, Springer.
2. Understanding Additive Manufacturing, by- Andreas Gebhardt, Hanser.
3. Additive Manufacturing, by- AmitBandyopadhyay, Susmita Bose, CRC Press.
4. Rapid Prototyping: Principles and Applications, by -Chee Kai Chua, Kah Fai Leong, Chu Sing Lim.

Semester – VI: Departmental Elective – V: Specialization – Production Engineering/ Industrial Production Engineering

Subject Code: KPI 071	Flexible Manufacturing System	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO-1	Understand the manufacturing systems, flexibility, components of FMS	K2
CO-2	Understand production, planning, scheduling and simulation of FMS	K2
CO-3	Understand concepts of group technology and economics issues in the application of FMS	K2
CO-4	Understand the application of FMS in various operations & involvement of AI in flexible manufacturing system.	K2
CO-5	Understand the concepts of scheduling and simulation in FMS	K2
CO-6	Apply the concepts of scheduling in FMS	K3

UNIT-I: Understanding of FMS

Introduction To FMS, Evolution of Manufacturing Systems, objective and Need, Benefits, Components, Types of Flexibility, Merits, Demerits and Applications of Flexibility.

Composition of FMS, CNC machines, robots, automatic storage and retrieval, automatic material handling, computerized control, Hierarchy of Computer Control ,Computer Control of Work Centre and Assembly Lines, FMS Supervisory Computer Control.

UNIT-II: Planning, scheduling and control of flexible manufacturing systems:

Process planning, machine loading, cycle time, machine output vs cycle time, methods to reduce cycle time, machine balancing.

Scheduling, data requirement for scheduling, mater production scheduling, Gantt charts, scheduling rules, scheduling in FMS, Single Product, Single Batch, N–Batch Scheduling Problem, Knowledge Based Scheduling System.

Dispatching, Dispatch activities.

UNIT-III: **FMS simulation and data base**

Application of Simulation, Model of FMS, Simulation Software, Limitation, Manufacturing Data Systems, Data Flow, FMS Database Systems, Planning For FMS Database.

Introduction to factors affecting the Performance of FMS, Introduction to Analytical model and Simulation model of FMS.

UNIT-IV: Group technology and justification of FMS

Introduction, Matrix Formulation, Mathematical Programming Formulation, Graph Formulation, Knowledge Based System for Group Technology, Economic Justification Of FMS, Implementation issues and maintenance of FMS, Application of Possibility Distributions in FMS Systems Justification.

UNIT-V: Applications of FMS and factory of the future

FMS Application in Machining, Sheet Metal Fabrication, Prismatic Component Production, Aerospace Application, FMS Development Towards Factories of The Future, Artificial Intelligence and Expert Systems in FMS, Design Philosophy and Characteristics for Future, case studies.

Books and References:

1. Jha, N.K. “Handbook of Flexible Manufacturing Systems”, Academic Press Inc., 1991.
2. Radhakrishnan P. And Subramanyan S., “CAD/CAM/CIM”, Wiley Eastern Ltd., New Age International Ltd., 1994.
3. Raouf, A. And Ben-Daya, M., Editors, “Flexible Manufacturing Systems: Recent Development”, Elsevier Science, 1995.
4. GrooverM.P., “Automation, Production Systems And Computer Integrated Manufacturing”, Prentice Hall Of India Pvt., New Delhi, 1996.
5. Reza A Maleki “Flexible Manufacturing system” Prentice Hall of Inc New Jersey, 1991
6. TaiichiOhno, “Toyota Production System: Beyond Large-Scale Production”, Productivity Press (India) Pvt. Ltd. 1992.

Semester – VII: Departmental Elective – V: Specialization – Production Engineering/ Industrial Production Engineering

Subject Code: KPI 072	Facility Planning and Design	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO-1	Understand the plant location and site selection, factors influencing the plant location, the plant layout and plant layout design techniques	K2
CO-2	Understand the group technology and formation of machine cells, balancing of manufacturing line.	K2
CO-3	Understand the material handling and flow pattern.	K2
CO-4	Use the concepts of plant location and site selection and its layout design.	K3
CO-5	Apply the concepts of group technology and manufacturing cell formation.	K3
CO-6	Use material handling technologies in the plant.	K3

UNIT -I

Factory Planning: Introduction, factors to be considered

Plant Location and Site Selection: Levels of plant location, rural, urban and suburban location of plants, factors influencing the plant location, optimum plant location, location theories.

UNIT -II

Plant Layout: Introduction of production system, scope, objectives, importance, and types of plant layout, characteristics of a good plant layout, factoring affecting plant layout, procedure of developing a plant layout, different graphical and computerized plant layout design techniques, installation and evaluation of plant layout, optimum plant layout.

UNIT -III

Group Technology: Definition, objectives, planning, part families and machine cell formation, evaluation of machine cells, types of GT layout, benefits of GT, implementation of GT.

UNIT -IV

Line Balancing: Definitions, heuristic and analytical methods of balancing the assembly and production line, single and mixed model line balancing.

UNIT -V

Materials Handling: Definition, scope, objectives, principles, importance, factors in materials handling problem, analysis of materials handling, types and selection of materials handling equipment's, aids and techniques in materials handling equipment selection. Planning of material flow, advantages of planned material flow, flow planning principles, flow patterns, analysis of material flow.

Recommended Books:

1. Francis, R.L., McGinnis, L.F., and White, J.A., "Facility Layout and Location: An Analytical Approach", Prentice Hall of India 2004

2. Meyers, F.E., and Stephens, M.P., “Manufacturing Facilities Design and Material Handling”, Prentice-Hall, Inc. 2000
3. Groover,M.P.,“Automation, Production Systems and ComputerIntegrated Manufacturing”,2nd 2001 Ed., Pearson Education Inc. Delhi
4. Sule,D.R.,“Manufacturing Facilities-Location, Planning, and Design”, PWS Publishing Company 1984
5. Tompkins,J.A., White, J.A.,Bozer,Y.A.,Frazelle, E.H.,Tanchoco, J.M., and Tervino,J.,“Facilities Planning”,2nd 1996 Ed., John Willey & Sons

Semester – VII: Departmental Elective – V: Specialization – Manufacturing and Automation

Subject Code: KME 073	Mathematical Modeling of Manufacturing Processes	L T P : 3 0 0	Credits: 3

Course Outcome: Student will be able to		Bloom Taxonomy
CO1	Understand the fundamentals of manufacturing processes, mathematical models and their solutions	K2
CO2	Understand unconventional and conventional machining, their discrete-time linear, non-linear models and solutions	K2
CO3	Analyze the mechanism of forming and heat transfer in welding	K4
CO4	Apply the principles of casting, powder metallurgy, coating and additive Manufacturing	K3
CO5	Understand the fundamental of heat treatment, micro / nano manufacturing and processing of non-metallic materials.	K2

Unit-1:

Introduction to Manufacturing processes; Materials Processing; Types and Properties of Engineered Materials; Evaluation of Properties of Manufactured Products; Statistical and data-driven modelling approach; Overview of mathematical modeling, types of mathematical models and methods to solve the same. Physics of manufacturing processes; Solid-state deformation (Elasticity and Plasticity) and residual stresses; solid-state phase transformation and recrystallization; melting and solidification; Coupled Systems

Unit-2:

Conventional machining; Orthogonal cutting; Tool geometry; chip formation; force components; heat generation; tool life; mathematical modelling approach; solution of problems; Introduction to discrete-time linear and non-linear models. Non-conventional machining; Principal and mechanism of different processes; Parametric analysis of heat transfer, material removal, and surface finish.

Unit-3:

Metal forming; Mechanics of bulk metal forming; mechanics of sheet metal forming; heat transfer and deformation; Welding; Fusion welding; Welding-heat source modeling, temperature distribution, effect of surface- active elements, modes of metal transfer in welding; Solid-state welding; Solidification and microstructure; Residual stress and distortion.

Unit-4:

Casting and powder metallurgy; Cooling and Solidification; principle of powder metallurgy; Coating and additive manufacturing; Principle of surface and coating technology; Principle and development of additive manufacturing technologies

Unit-5:

Heat treatment; Fundamentals of heat treatment; Evaluation of microstructure properties and residual stress of different manufacturing processes. Micro/nanoscale manufacturing; Down-scaling of conventional manufacturing processes, Change of properties, Micro-to-nano manufacturing; Packaging, finishing, micro joining and nano joining, micro casting, micro forming, micromachining. Processing of non-metallic materials; Principle of plastic processing and shaping of plastics, processing of non-metallic bio-materials; Principle of glass and ceramics processing and shaping of glass and ceramics.

Books and References

1. A Ghosh and A K Mallik: Manufacturing Science, East-West Press Pvt Ltd, 2nd Ed., 2010.
2. D A Brandt, J C Warner: Metallurgy Fundamentals, Goodheart- Willcox, 2009.
3. C Lakshmana Rao and Abhijit P Deshpande: Modelling of Engineering Materials, Ane Books Pvt. Ltd., New Delhi, India, 2010.
4. J. Chakrabarty: Theory of plasticity, 3rd Eds, Elsevier India, 2009.
5. Norman Y Zhou: Microjoining and Nanoioining, Woodhead publishing, 2008
6. R W Messler: Principles of Welding John Wiley and Sons, 1999.
7. J T Black and Ronald A Kohser: DeGarmo's Materials & processes in Manufacturing Wiley-India, 2010.
8. V K Jain: Advanced Machining Processes, Allied Publishers, Mumbai, 2002.
9. Yi Qin: Micromanufacturing Engineering and Technology, Elsevier, 2015.
10. J Zhang and Yeon-Gil Jung: Additive Manufacturing: Materials, Processes, Quantifications and Applications, Elsevier, 2018.
11. J A Dantzig and M Rappaz: Solidification, CRS press, 2009.
12. J.N. Kapur, Mathematical Models in Biology and Medicine, East-West Press Private limited.
13. Leah, Edelstein, Keshet, Mathematical Models in Biology, SIAM publications.
14. J.D. Murray, Mathematical Biology Vol. I, II, 3rd edition, Springer publications.

Related Course's / Useful Links

1. https://www.digimat.in/nptel/courses/video/112103273/L01.html
2. https://swayam.gov.in/nd1_noc20_ma47/preview

Semester – VII: Departmental Elective – V: Specialization – Automation and Industry 4.0

Subject Code: KME 074	Machine Learning	L T P : 3 0 0	Credits: 3

Course Outcomes: Students are able to		**Bloom's Taxonomy**
CO 1	Understand the need of machine learning concepts	K2
CO 2	To Understand a wide variety of ML Algorithms and how to evaluate models generated from data	K3
CO 3	Solve prediction based problems	K3
CO 4	Analyze machine learning algorithms	K4
CO 5	Apply the Algorithms to real-world problems	K4

Unit 1: Introduction to Machine Learning (6Hours)

An Introduction to Machine Learning, Types of Machine Learning, and Applications of ML in Mechanical Engineering, Designing a Learning System, Performance Measures for ML Model, Issues in Machine Learning, AI vs. ML, and Essential Math for ML and AI, Data Science Vs Machine Learning

Unit 2: Supervised Learning (9Hours)

Supervised Learning: Introduction to Supervised Learning, Classification, Regression Analysis and its Types , Model Selection Procedures, Bayesian Decision Theory, Naïve Bayes Classifier, Bayes Optimal Classifier, Evaluating an Estimator: Bias and Variance , Support Vector Machines, Types of Support Vector Kernel(Linear Kernel, Polynomial Kernel, Gaussian Kernel, Issues in SVM, Case Study on House Price Prediction using Machine Learning.

Unit 3: Unsupervised Learning (9Hours)

Unsupervised Learning: Introduction to Unsupervised Learning, Cluster Analysis, K-Means Clustering, Expectation-Maximization Algorithm, Dimensionality Reduction: Principal Components Analysis, Independent Component Analysis, Multidimensional Scaling, Linear Discriminant Analysis.

Unit 4: Decision Tree & Neural Networks (9Hours)

Decision Trees: Basics of Decision Tree, Issues in Decision tree learning, ID3 Algorithm, Information gain and Entropy.

Introduction to Neural Networks: Perceptron, The Back propagation Algorithm, The Convergence analysis and universal approximation theorem for back propagation algorithm, Concept of Convolution Neural Networks, Types of Layers of CNN, Case Study of CNN (either on Self driving car, Building a smart speaker, etc.)

Unit 5: Genetic Algorithms & Reinforcement Learning (7Hours)

Genetic Algorithm: Introduction, Components of Genetic Algorithm, CrossOver, Mutation, Model of Evolution and Learning, Applications of Genetic Algorithm

Reinforcement Learning: Introduction to Reinforcement Learning, Learning task, Model-Based Learning Q- Learning, Markov Decision Process, Q Learning Function, Temporal Difference Learning, Generalization,

Text Book:

1. Tom M. Mitchell, —Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
2. Ethem Alpaydin, — Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.
3. Stephen Marsland, —Machine Learning: An Algorithmic Perspective, CRC Press, 2009.
4. Bishop, C., Pattern Recognition and Machine Learning. Berlin: Springer-Verlag.

Semester – VII: Departmental Elective – V: Specialization –Production Engineering/ Industrial Production Engineering

Subject Code: KPI 073	Project Management	L T P : 3 0 0	Credits: 3

The students will be able to		Blooms Taxonomy
CO-1	Understand the concepts, applications and advantages of Project Management.	K2
CO-2	Understand the monitoring of the project and its control.	K2
CO-3	Understand project appraisal and cost estimation.	K2
CO-4	Apply the techniques of project planning and scheduling.	K3
CO-5	Understand the project management software	K2

UNIT-I

Concepts of project management (PM)

Introduction of Project: Definitions & Characteristics of Project, Types of Projects, Project Life Cycle, Project Management Process: Introduction, Tools & Techniques of Project Management. Project Team and Scope of Project Management: Characteristics of a Project Team & Project Leader, Project Organization, and Importance of Project Management, project planning and graphic presentation; work breakdown structure, Establishing the project and goals, Project feasibility Analysis: Technical feasibility, commercial and financial visibility, Environment Analysis

UNIT-II

PROJECT MONITORING AND CONTROL

Dimensions of Project Monitoring & Control, Project Management Information System, Earned Value Analysis: Planned Value (PV), Earned Value (EV), Cost Variance (CV), Schedule Variance (SV), Cost performance Index (CPI), Schedule performance Index (SPI), Project Termination: Types of Terminations, Project Termination Process

UNIT-III

PROJECT APPRAISAL & COST ESTIMATION

Introduction, technical appraisal, Financial Appraisal, Institutional Appraisal , commercial appraisal, Environmental Appraisal, economic appraisal, Legal Appraisal , Methodology of Project Appraisal

PROJECT APPRAISAL TECHNIQUES: Non-Discounting Techniques- Urgency, Payback Period, Accounting Rate of Return, Debt Service Coverage Ratio. Discounting Criteria Techniques- Net Present Value(NPV), Benefit Cost Ratio(BCR) , Internal Rate of Return(IRR), Annual Capital Charge

UNIT-IV

Project Planning & Scheduling: Introduction to PERT &CPM, planning and scheduling networks, time estimation. determination of critical path and its length, expected length of critical path, calculating the

project length and variance, event slack and floats, Expected time for activities, PERT &CPM cost accounting systems, lowest cost schedule, crashing of networks, linear programming formulation of event-oriented networks, Line of balance (LOB) technique, Introduction to project scheduling software like overview of MS-project-2000, Project Libre, WBS Schedule pro, Smart Draw, etc.

UNIT-V

Modification & Extensions of Network Models: Complexity of project scheduling with limited resources, resource levelling of project schedules, resource allocation in project scheduling - heuristic solution. Precedence networking- examples with algorithm, decision networks, probabilistic models in networks.

Project Management Software: Introduction, Advantages of Using Project Management Software, Common Features Available in Most of the Project Management Software, essential requirements of PM software, working on any project management software like Teamwork, Basecamp, Zoho, Proofhub, Celoxisetc

Books and References:

1. Project Management by Harvey Maylor, Pearson India.
2. Project Management by Choudhury, McGraw Hill.
3. Project Management by K. Nagarajan.
4. Project Management: A Systems Approach to Planning, Scheduling and Controlling, by Kerzner, Willey.
5. Project Management: A Life Cycle Approach by Kanda, PHI, India.
6. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
7. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999. 8. Project Management and Appraisal, by Khatua, Oxford University Press.