

**DAV UNIVERSITY JALANDHAR**



**Course Scheme & Syllabus**

**Master of Technology**

**In**

**Industrial & Production Engineering**

**Session 2018 (Onwards)**

## Scheme of M. Tech in Industrial and Production Engineering

### SEMESTER-I

S. No	Subject Code	Name of Subject	L	T	P	Credits
1.	MEC751	Casting and Welding Technology	4	0	0	4
2.	MEC752	Advance Manufacturing Processes	4	0	0	4
3.	MEC753	Metal Cutting and Machine tool design	4	0	0	4
4.	MEC754	Production Planning and Control	4	0	0	4
5.	MEC755	Product Design and Development	4	0	0	4
6.	MEC756	Advance Manufacturing Technology Lab	0	0	4	2
<b>Total</b>			<b>20</b>	<b>0</b>	<b>4</b>	<b>22</b>

### SEMESTER-II

S. No	Subject Code	Name of Subject	L	T	P	Credits
1.	MEC761	Metrology and Computer Aided Inspection	4	0	0	4
2.	MEC715	Research Methodology	4	0	0	4
3.	MEC762	Total Quality Management	4	0	0	4
4.		Elective - 1	4	0	0	4
5.		Elective - 2	4	0	0	4
6.	MEC765	Seminar and Dissertation Writing	0	0	4	2
<b>Total</b>			<b>20</b>	<b>0</b>	<b>0</b>	<b>22</b>

### SEMESTER-III

S. No	Subject Code	Name of Subject	L	T	P	Credits
1.	MEC763	Method Engineering and Ergonomics	4	0	0	4
2.	MEC764	Industrial Engineering Lab	0	0	4	2
3.		Elective - 3	4	0	0	4
4.	MEC795	Dissertation Phase - 1	0	0	12	6
<b>Total</b>			<b>8</b>	<b>0</b>	<b>16</b>	<b>16</b>

### SEMESTER-IV

S. No	Subject Code	Name of Subject	L	T	P	Credits
1.	MEC796	Dissertation Phase-II	0	0	24	12

**ELECTIVE-I**

<b>S. No</b>	<b>Subject Code</b>	<b>Name of Subject</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1.	MEC705	Robotics	4	0	0	4
2.	MEC702	Advanced Mechatronics	4	0	0	4
3.	MEC721	Industrial Automation	4	0	0	4
4.	MEC775	Advanced Materials	4	0	0	4
5.	MEC703	Computer integrated manufacturing system	4	0	0	4
6.	MEC777	Casting & Welding Metallurgy	4	0	0	4
<b>Total</b>			<b>24</b>	<b>0</b>	<b>0</b>	<b>24</b>

**ELECTIVE-II**

<b>S. No</b>	<b>Subject Code</b>	<b>Name of Subject</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1.	MEC781	Organization Theory and Behaviour	4	0	0	4
2.	MEC782	Material Management	4	0	0	4
3.	MEC783	Entrepreneurship	4	0	0	4
4.	MEC784	Management Information System	4	0	0	4
5.	MEC785	Industrial Psychology	4	0	0	4
<b>Total</b>			<b>20</b>	<b>0</b>	<b>0</b>	<b>20</b>

**ELECTIVE-III**

<b>S. No</b>	<b>Subject Code</b>	<b>Name of Subject</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1.	MEC711	Computer Control of Machine Tools	4	0	0	4
2.	MEC786	Tribology	4	0	0	4
3.	MEC787	Maintenance and Reliability	4	0	0	4
4.	MEC788	Optimization Techniques	4	0	0	4
5.	MEC789	Business Policy and Strategies	4	0	0	4
6.	MEC790	Instrumentation and Control	4	0	0	4
<b>Total</b>			<b>24</b>	<b>0</b>	<b>0</b>	<b>24</b>

**Course Title: Casting and Welding Technology**

**Paper Code: MEC751**

L	T	P	Credits
4	-	-	4

**Objective:** The main goal of this subject is

- To learn the industrial applications of welding and casting.
- To recognize the required data and information to optimize the design of each process.

### UNIT-A

**Patterns, Moulding and Core Making Processes:** Pattern design, recent development in pattern design, material and construction, review and critical comparison of various established processes, recent developments e.g. low pressure and ferrous die casting, high pressure moulding, full mould process, flask less moulding, hot and cold box moulding, ceramic shell moulding etc.

**Solidification:** Solidification of pure metals and alloys, nucleation and growth in alloys, progressive and directional solidification, centerline feeding resistance; rate of solidification, Chvorinov's Rule.

### UNIT-B

**Gating and Riser:** Gating system and their characteristics, the effects of gate on aspiration, turbulence and dross trap, riser design, riser curves, NRL method riser design, feeding distance, Riser of complex casting.

**Fluidity and Gases in Metals:** Measurement of fluidity, effects of various parameters on fluidity, methods of elimination and control of dissolved gases in casting.

### UNIT-C

Welding and its classification, Electric arc heat source, arc characteristics, arc stability, arc welding power sources, power source characteristics, V-I relationship, different types of electrodes and their applications.

**Gas Metal Arc Welding:** Basic principle, equipments, welding parameters, different modes of metal transfer, various factors affecting metal transfer mode, pulsed MIG welding, Synergic MIG welding.

**Gas Tungsten Arc Welding:** Basic principle, equipment, influence of polarity on bead characteristics, different tungsten electrodes and shielding gases used, pulsed TIG welding and latest trends in TIG welding.

### UNIT-D

**Submerged Arc Welding:** Basic principle, equipments, process variables and their effects, significance of flux-metal combination, modern developments, narrow gap submerged arc welding, and applications.

**Plasma Arc Welding:** Special features of plasma-arc, transferred and non-transferred arc, keyhole and puddle-in mode of operation, low current and high current plasma arc welding and their applications, plasma cutting, surfacing and applications.

**Resistance Welding:** Principle of contact resistance, temperature distribution, spot welding cycle, inter-relationship between process variables; choice of electrode materials, spot, seam, projection, stud, upset and flash butt welding.

**References:**

- 1) Parmar R. S., *Welding Processes and Technology*. New Delhi: Khanna Publishers. 2012. Print.
- 2) Nadkarni, S.V., *Modern Arc Welding Technology*. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd. 2009. Print.
- 3) Parmar R. S., *Welding Engineering and Technology*. New Delhi: Khanna. 2012. Print.
- 4) Lancaster J.F, *The Physics of Welding*, Pergamon Press, 1984
- 5) Richard L. Little., *Welding and Welding Technology*. New Delhi: McGraw Hill Education. 2017. Print.

**Course Title: Advance Manufacturing Processes**

**Paper Code: MEC 752**

**Objective:** Students will learn about

- Non-conventional machining processes, its construction features, Comparison of its aspects.
- Principles, analysis, control parameters and its effect on the response parameters.

L	T	P	Credits
4	-	-	4

### UNIT-A

**Introduction:** Need of non- conventional machining processes, classification of modern machining processes, process selection, the benefits, and limitations over conventional machining processes.

**Mechanical Energy Based Processes:** Working principles, elements of the process, process parameters, analysis of machining, response characteristics, Applications of the Abrasive Jet Machining, Water Jet Machining, Abrasive water Jet Machining, Ultra sonic machining.

### UNIT -B

**Electro Chemical and Chemical Based Processes:** Working principles, elements of the process, process parameters, analysis of machining, response characteristics, Applications of the electro chemical and chemical processes, Electro chemical grinding, Electro Chemical Deburring, Electro Chemical Honing, Numericals.

### UNIT -C

**Electrical Energy Based Processes:** Working principles, elements of the process, process parameters, analysis of machining, response characteristics, Applications of the Electro-discharge machining, laser beam machining, plasma arc machining.

### UNIT -D

**Rapid Prototyping:** Introduction, steps in RPT, Major RP technologies, Rapid manufacturing, Applications of RPT, future developments, limitations and challenges.

### References:

- 1) Pandey P.C and Shan H.S, *Modern Machining Processes*, Tata McGraw Hill education Pvt. Ltd., 1980.
- 2) Jain V.K., *Advanced Machining Processes*, Allied Publishers Pvt. Ltd. New Delhi, 2007.
- 3) Kalpakjian S., *Manufacturing Engineering & Technology*, Pearson Education Asia, 7<sup>th</sup> edition, 2014.
- 4) Ghosh & Mallick, *Manufacturing Science*, New Age Publishers Pvt. Ltd. New Delhi, 4<sup>th</sup> edition 2011.
- 5) Mishra, P.K., *Non -Conventional Machining*, Narosa Publishing House, Delhi, 1997

**Course Title: Metal Cutting and Machine Tool Design**

**Paper Code: MEC 753**

L	T	P	Credits
4	-	-	4

**Objective:**To impart the fundamental notions of

- The metal cutting and machine tools including mechanics of machining, different parameters, the different types of machine tool.
- Construction, applications and their technological capabilities.
- To provide exposure to the systematic methods for solving the problems of designing machine tools.

### UNIT-A

**Introduction:** System of Tool nomenclature, Tool Geometry, Mechanism of Chip formation and forces in orthogonal cutting, Merchant's force diagram, Factors affecting cutting temperature, Tool wear and Tool Life.

**Oblique Cutting:** Normal chip reduction coefficient under oblique cutting, true shear angle, effective rake, influx region consideration for deformation, direction of maximum elongation, effect of cutting variables on chip reduction co-efficient, forces system in oblique cutting.

### UNIT -B

**Dynamometry:** Fundamentals of Dynamometry, Theoretical determination of forces, angle relations, heat and temperature during metal cutting; distribution, measurement, analysis, theoretical estimation of work piece temperature.

### UNIT -C

**Cutting Tool Materials and Cutting Fluids:** Introduction, Types of Cutting tool materials, Cutting Fluids, Properties of Cutting Fluids, Types of Cutting Fluids, Requirement of good cutting fluid, and Selection of a cutting fluid &Effect of fluids on cutting variables.

**Cutting Tool Failure Analysis:** Tools materials analysis of plastic failure (from stability criterion), Analysis failure by brittle fracture, wear of cutting tools, criterion, flank, and crater wear analysis, optimum tool life.

### UNIT -D

**Machine Tool Design:** Design requirements of machine tools, A design approach for machine tools, Identification and quantification of objectives and constraints in machine tool design, Estimation of power requirements and selection of motor for metal cutting machine tool spindles, Design of gearbox, spindle and guide ways, Principles of design of structural components, namely, head stock, tail stock, carriage, table, knee, column and over arms to achieve desired static and fatigue strength, stiffness, dynamic characteristics and other requirements.

## References:

- 1) Brown.,*Machining of Metals*. Prentice hall. Print,1969.
- 2) Shaw.,*Principles of Metal cutting*. Oxford I.B.H. Print,2014.
- 3) Arshimov&Ale kree.,*Metal cutting theory & Cutting tool design*. MIR Publications. Print,1970.
- 4) Shan, H. S.,*Modern Machining Processes*.New Delhi: Tata McGraw Hill Publishing Co., 2002. Print.
- 5) Jain, Serope, Kalpak.,*Manufacturing engineering and Technology*. Addison Wesley Publishing Co., 1995. Print.
- 6) Ghosh, Amitabh.,*Manufacturing Processes*. New Delhi: Tata McGraw Hill Publishing Co., 2001. Print.
- 7) N Acherkan., "*Machine Tool Design*", Volume- 1-4, MIR Publishers, Moscow, 1969.



**Course Title: Production Planning and Control**

**Paper Code: MEC754**

L	T	P	Credits
4	0	0	4

**Objective:**

- Measure the effectiveness, identify likely areas for improvement, develop and implement improved planning and control methods for production systems.
- Identify different strategies employed in manufacturing and service industries to plan production and control inventory.

### UNIT-A

**Concepts of Production Planning & Control:** Concept of Production System, Types of production systems (Job Order Production, Batch Production, and Continuous Production), Concepts of PPC, Definitions, Objectives and Functions of PPC, Organization of PPC Department, Production Planning, Production Control, Principles of sound production control system.

**Sales Forecasting and Market Analysis:** Introduction, Types of forecasting, Objectives and importance of sales forecasting, Process of sales forecasting, Advantages and disadvantages of sales forecasting, Factors affecting forecasting, Methods of sales forecasting, Market analysis.

### UNIT -B

**Process Planning, Operation Planning and Capacity Planning:** Process planning, Pre requisites of process planning, Steps in process planning, Factors affecting process planning, Make or Buy decision, Operation Planning, Capacity Planning.

**Aggregate Planning: MRP and MPS:** Aggregate planning, Cost relevant with aggregate planning, Concept of MRP, Inputs to MRP (MPS, Bill of materials, Inventory status file), Working of MRP, MRP Outputs, Computerized system of MRP, Benefits and limitations of MRP.

**Selection of Materials, Methods, Machines and Manpower:** Selection of materials, Process selection, Machine selection, Recruitment and selection of manpower.

### UNIT-C

**Routing, Scheduling and Dispatching:** Routing (Routing procedure, Route Sheet, Routing in different production system), Scheduling (Factor affecting scheduling, Master schedule, production schedule and Machine loading), Dispatching (Work order documents, Dispatching rules, Centralized and Decentralized dispatching)

**Line Balancing:** Introduction, Terminology, Methods

**Progress Control:** Progress control through records and charts, Functions of progress control

## UNIT -D

**Factory Location, Plant Layout and Material Handling:** Nature of location decisions, Importance of plant location, Choice of site for location, State regulations on location, Comparison of locations, Suburban area, Economic survey of site selection, Plant layout, Situations, in which plant layout problem may arise, Factors influencing plant layout, Principles of plant layout, Techniques used in plant layout, Types, Symptom of bad plant layout, Storage space requirement, Flow pattern, Material Handling, Factors to be considered in material handling problems, Principles of material handling, Material handling devices.

### References

- 1) Mahajan M., *Production Planning & Control*. New Delhi: Dhanpat Rai & Co. Print.
- 2) Buffa., *Production and Operations Management*. Wiley. Print-8ed, 2007.
- 3) Jain and Agarwal., *Production Planning & Control*. New Delhi: Khanna Publishers, 2004.
- 4) Bhatt Shridara, k., *Production and Operation Management*. New Delhi: Himalaya Publication, 2011.
- 5) Dalela S, Ali Mansoor., *Industrial Engineering and Management Systems*. Standard Publishing Distributors, 2000.
- 6) Philip E Hicks., *Industrial Engineering & Management –A new perspective*. Tata McgrawHill.

**Course Title: Product Design and Development**

**Paper Code: MEC 755**

L	T	P	Credits
4	-	-	4

**Objective:**

- To introduce the objectives of product design and the requirements of a good product design.
- To expose the students to different design principles like designing for function, production, installation and handling, maintenance, packaging etc.

#### **UNIT-A**

**The Process of Product Design:** Design by evolution, Limitations of evolutionary method in modern design situation, Structure of design process, Morphology of design, Specifications and Standards of performance, Environmental factors, Creativity techniques in design problem.

#### **UNIT -B**

**Strategies for Search of Design Concepts:** Physical realizability, Economic and financial feasibility, Designing for function, Designing for production, Tolerance analysis, Use, Maintenance, Designing for handling and installing, Economics of design, Human factors in design, Optimization of design, Reverse engineering of ergonomic shape designs, Visual design.

#### **UNIT -C**

**Use of CAD / CAM /CAE:** Software for concurrent engineering design. Case studies in design of products for manufacture, Aesthetics, Surface styling and shaping tools in modern CAD software, Exercises in design, Reverse engineering and surface design and review software.

#### **UNIT -D**

**Elements of Testing:** qualitative and quantitative methods including survey, measurement of customers' response, Intellectual Property: Elements and outline, patenting procedures, claim procedure. Design for Environment: Impact, regulations from government, ISO system.

## References:

- 1) Gupta, V. and Murthy, P.N., *Introduction to Engineering Design Method*, McGraw Hill 1980.
- 2) Chitale, A. K. and Gupta, R. C., *Product Design and Manufacturing*, Prentice Hall of India 2004.
- 3) Ulrich, K. T. and Eppinger, S. D., *Product design and development*, Tata McGraw Hill Publications.
- 4) Kelvin, O. and Krista, W., *Product design*, Pearson Education, Delhi, 2001.
- 5) Bruce, M. and Rachel, C., *Creative product design*, Johan Willey & sons Ltd., New York, 2000.

**Course Title: Advance Manufacturing Technology lab**

**Paper Code: MEC 756**

**Objective:** Students will learn the practical learning objectives in the lab related to advance manufacturing technology.

L	T	P	Credits
-	-	4	2

**List of Experiments:**

- 1) To perform the various lathe operations on the given job.
- 2) To perform the welding on TIG welding set-up.
- 3) To perform the welding on MIG welding set-up.
- 4) To develop the part programme of a given job to be machined on CNC lathe.
- 5) To develop the part programme of a given job to be machined on CNC machining centre.
- 6) To study the construction and working of CNC turning centre.
- 7) To study the construction and working of CNC machining centre.
- 8) To study the construction and working of CNC EDM machine.
- 9) To study the construction and working of CNC Wire EDM machine.
- 10) To study the construction details of ECM set-up and its working principal.
- 11) To study the construction and working of selective layer rapid prototyping technique.

**Note: Students required to perform any eight experiments from the above mentioned list.**

**Course Title: Metrology and Computer Aided Inspection**

**Paper Code: MEC 761**

L	T	P	Credits
4	-	-	4

**Objective:** The aim of this course is to teach

- The applications of various Metrology techniques for a variety of problems occurring in industries.
- To understand various methods of inspection and understand the basic concepts in Metrology and Computer Aided Inspection.

### UNIT-A

**Metrology Concepts:** Abbe's principle-need for high precision measurements-problems associated with high precision measurements.

**Standards for Length Measurement-**Shop floor standards and their classification -Light interference-Method of coincidence-Slip gauge calibration-measurement errors.

### UNIT -B

**Metrology and Techniques:** Standards in metrology, definitions, Traceability, Characteristics Length & Angular measurements-Review of standard instruments, GD and tolerance procedure-Review of dimension & form tolerance and methods of measurement, Tolerance analysis, Surface metrology-Instruments, Methods and new approaches.

**Laser Applications in Metrology:** LASER light source, LASER interferometer, LASER alignment telescope, LASER micrometer, On-line and in-process measurements of diameter, Roundness and surface roughness using LASER, Micro holes and topography measurements.

### UNIT -C

**Special Measuring Instruments and Techniques:** Optoelectronic devices, contact and non-contact types, Applications in on-line and in-process monitoring systems, Tool wear measurement, Surface measurement, Machine vision, shape identification, Edge detection techniques, Normalization, gray scale correlation, Template Techniques, Surface roughness using vision system, Interfacing robot and image processing system. Surface and form metrology-Flatness, roughness, waviness, roundness, cylindricity, etc. Computer Aided Metrology-principles and interfacing, software metrology.

### UNIT -D

**Co-ordinate Measuring Machine:** Types of CMM, Probes used, Applications, Non-contact CMM using electro optical sensors for dimensional metrology, Non-contact sensors for surface finish measurements, statistical evaluation of data using computer, Data integration of CMM and data logging computers.

**Sensors in Inspection:** Manufacturing applications of photo detectors, deflection methods-beam detection, Reflex detection, & Proximity detection, Applications of

Inductive and Capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches. Advanced sensor technology-Bar code systems, Principles and applications of Colour sensors, electro-magnetic identifier, Tactile sensors, Ultrasonic sensors, Odour sensors.

**References:**

- 1) Shotbolt, C.S. and Galyer. J.,*Metrology for Engineers*, Cassell Publ., Fifth Edition, 1990.
- 2) Busch T. and Delmar R. Harlow,*Fundamentals of dimensional Metrology*, Cengage Learning; 5 edition
- 3) Thomas G. and Butter G.,*Engineering Metrology* Worth PUB
- 4) SabneSoloman, *Sensors and Control systems in Manufacturing*, McGraw Hill Book
- 5) Robert G. Seippel.,*Optoelectronics for Technology and Engineering* Prentice Hall India.

**Course Title: Research Methodology**

**Paper Code: MEC715**

**Course Objective:** The course is designed

L	T	P	Credits
4	-	-	4

- To introduce the students to research methodology and application of research techniques and procedures.
- The primary goal of this course is to develop a sound understanding of research methods.

### UNIT – A

**Introduction to Research:** Objectives and Types of Research, Research Approaches, Significance and process, Criteria of Good Research, Selecting the Problem, Necessity of Defining the Problem and Technique Involved in Defining a Problem.

**Research Design:** Research Design and its need, Features of a Good Design, Different Research Designs, Basic Principles of Experimental Designs, Factors affecting RDs, Relation among RDs, Developing a Research Plan.

### UNIT – B

**Sampling Design:** Census and Sample Survey, Steps in Sampling Design, Sampling Procedure, Characteristics and Different Types of Sample Designs, Selection of a Random Sample, Complex Random Sampling Designs.

**Measurement and Scaling Techniques:** Measurement in Research, Measurement Scales, Sources of Error in Measurement, Scaling, Meaning of Scaling, Scale Classification Bases, Important Scaling Techniques, Scale Construction Techniques.

### UNIT – C

**Methods of Data Collection:** Collection of Primary Data, Observation Method, Interview Method, Questionnaires and Schedules, Some Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection.

**Processing and Analysis of Data:** Measures of Central Tendency, Dispersion, Asymmetry (Skewness), Measures of Relationship Simple Regression Analysis, Multiple Correlation and Regression, Partial Correlation, Association in Case of Attributes, Other Measures.

**Sampling Fundamentals:** Need for Sampling, Sampling Distributions, Central Limit Theorem, Sampling Theory, Sandler's A-test, Concept of Standard Error, and Estimation, Estimating the Population Mean, Estimating Population Proportion, Sample Size and its Determination.

### UNIT – D

**Testing of Hypotheses (Parametric or Standard Tests of Hypotheses):** Basic Concepts and Procedure for Hypothesis Testing, Flow Diagram for Hypothesis Testing, Tests of Hypotheses, Important Parametric Tests, Hypothesis Testing of Means,



Hypothesis Testing for Differences between Means, Hypothesis Testing for Comparing Two Related Samples, Hypothesis Testing of Proportions, Hypothesis Testing for Difference between Proportions, Hypothesis Testing of Correlation Coefficients.

**Design of Experiments and Analysis of Variance and Covariance:** Taguchi and RSM, Analysis of Variance (ANOVA), The Basic Principle of ANOVA, ANOVA Technique, Setting up Analysis of Variance Table, Short-cut Method for One-way ANOVA, Coding Method, Two-way ANOVA, ANOVA in Latin-Square Design, Analysis of Co-variance (ANOCOVA), ANOCOVA Technique, Assumptions in ANOCOVA.

### **References:**

- 1) Kothari, C.R. *Research Methods and Techniques*, New Age Publishers. 3<sup>rd</sup> Edition 2014 Print.
- 2) Srivastava, T.N. *Business Research Methods*, TMH. Print-2010.
- 3) Bajpai Naval, *Business Research Methods*, Pearson Publications. Print-2011.
- 4) Malhotra, Naresh K. *Marketing Research: An Applied Orientation*, 5th Edition. Pearson/ Prentice-Hall, 2007. Print.
- 5) Proctor Tony, *Essentials of Marketing Research*, Prentice Hall, 4th Edition 2005, Print.

**Course Title: Total Quality Management**

**Paper Code: MEC762**

**Objective:**

L	T	P	Credits
4	-	-	4

The aim of this course is to help students understand and utilize

- The concepts of Total Quality Management and Continuous Process Improvement in order to improve product's quality and competitiveness.
- Introduction to the fundamental concepts of statistical process control, total quality management, and the application of these concepts.

### UNIT-A

**Introduction:** Basic concepts in Quality, Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership: Concepts, Role of Senior Management, Quality Council, Quality Statements, and Strategic Planning.

**Statistical Process Control (SPC):** The seven tools of quality, Statistical Fundamentals: Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Acceptance sampling methods-single, multiple and sequential sampling plans; Recent developments in inspection methods. Process capability, Six Sigma: Concepts, Steps and Tools, New seven Management tools.

### UNIT -B

**TQM Principles:** Customer satisfaction: Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement: Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement: Juran Trilogy, PDSA Cycle, 5S, Kaizen, Quality Circles, Quality Models for organizational excellence.

**Introspection to TQM environment:** Sphere of TQM, components of TQM, TQM – Managing Total Quality, Factors affecting TQM environment, Classification and interaction among factors, Researchers' viewpoint, TQM as a system, steps in TQM implementation, Roadblocks in TQM implementation, Reasons for TQM failure

### UNIT -C

**TQM Tools:** Benchmarking: Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD): House of Quality, QFD Process, Quality by Design (Concurrent Engineering), Total Productive Maintenance (TPM): Concept, Improvement Needs, FMEA: Stages of FMEA.

**TQM Effectiveness :** Impact of TQM, Need and difficulty in measuring TQM effect, Parameters governing effect of TQM and the attributes thereof.

## UNIT -D

**Quality Management Systems:** Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000: Concept, Requirements and Benefits. Certification Requirements, Evolving Standards, Benchmarking and Auditing, Reaching World Class Standards.

### References:

- 1) Besterfield Dale H ,*Total Quality Management*,Prentice Hall College Div. Print-1995.
- 2) Oakland, *Total Quality Management*, Butterworth – Heinemann Ltd. Print-2003.
- 3) Feigenbaum.A.V.,*Total Quality Management*, McGraw-Hill. Print, 4<sup>th</sup> Edition 2004.
- 4) LogothetisN. ,*Managing for total quality from Deming to Taguchi and SPC*, PHI, Print-1993.
- 5) John Gilbert, *A slice by slice guide to TQM*, Affiliated East West Press,1993.
- 6) Waller Jenny, Allen Derek and Burna Andrew, *The TQM toolkit – a guide to practical techniques for TQM*, Kogan Page. Print-1995.

**Course Title: Seminar and Dissertation Writing**  
**Paper Code: MEC 765**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
0	0	4	2

The students will present a seminar on a topic related to M. Tech scheme and the students will learn how to write the dissertation chapters.

**Course Title: Method Engineering and Ergonomics**

**Paper Code: MEC763**

**Course Objective:**

- To conduct time and motion study to improve the methods/system.
- To impart the knowledge on ergonomics to enhance productivity of the organization.

L	T	P	Credits
4	-	-	4

### UNIT -A

**Work Study:** Introduction, Component of work study, Definition, Need of work study, Applications and advantages of work study, Work study procedure.

**Method Study:** Definition, Objective and Procedure of method study, Recording Techniques: Process Chart, Outline/Operation process chart, Flow process chart. Two handed process chart, Multiple activity chart, Travel chart, Flow diagram, String diagram, Cyclegraph and Cronocycle graph.

**Motion and Film Analysis:** Micro motion study, Therbligs, SIMO Chart, Memo motion study, Models(2D and 3D)

### UNIT-B

**Work Measurement:** Definition, Objective and benefit of work measurement, Basic procedure of work measurement.

**Work Measurement Techniques**

**Work sampling:** Need, confidence levels, sample size determinations, random observation, and conducting study with the simple problems.

**Stop Watch Time Study:** Time Study, Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating & standard Rating, standard performance, scale of rating, factors affecting rate of working, allowances and standard time determination.

**Predetermined Motion Time Study (PMTS)**

**Method Time Measurement (MTM)**

### UNIT-C

**Ergonomics:** Introduction, Areas of study under Ergonomics, System approach to Ergonomics model, Man-Machine System. Components of Man Machine System and Their functions – Work capabilities of Industrial Worker, Design of work space, chair table.

**Controls:** Hand controls and foot controls, location of controls and work place envelope. Recommendation about hand and foot push buttons, rotary selector switches, hand wheels, crank levers etc. Instruments and displays.

**Work Load:** Static and dynamic muscular work, Human motor activity, metabolism, physical work load, measurement of physical work load, mental work load, measurement of mental work load, repetitive and inspection work, work duration and rest pauses, principles of motion economy.

## UNIT-D

**Climate:** Heat Humidity: Body heat balance, effective temperature scales, and zones of discomfort, effect of heat on body and work performance

**Vibration:** Terminology, Response of body to low frequency (LF) vibration, vibrations and discomfort, effect on health of worker, high frequency vibration, effect of H.F. vibrations, methods of reducing vibrations, analysis.

**Noise:** Terminology, physiological effects of noise, annoyance of noise, speed interference, hearing loss, temporary and permanent thresh hold shift, effect of noise on performance, reduction of noise, personal noise protection.

### Reference books

- 1) DalelaandAli,Mansoor.*Industrial Engineering and Management Systems*. New Delhi Standard Publishing Distributors. Print.
- 2) Wickens.*An introduction to Human Factors Engineering*.NewDelhi:PHI. Print.
- 3) Ralph Barnes, *Motion and Time study*. John Wiley. 8thEdition. 1985. Print.
- 4) Sanders and McCormick E. J., *Human Factors in Engineering Design*. Tata McGraw Hill. 6<sup>th</sup>Edition. Print.
- 5) Wledon, *Engineered work Measurement*. ELBS. 1991.Print.
- 6) Shah, H.S.*Work study and Ergonomics*.New Delhi: DhanpatRai& Sons. 1992. Print.
- 7) Bridger.*Introduction of Ergonomics*. Tata McGraw Hill. 1995. Print.
- 8) Lyle, Yerges, F. *Sound, Noise and Vibration Control*. Van Nostrand.1978. Print.

**Course Title: Industrial Engineering Lab**

**Paper Code: MEC764**

**List of Experiments:**

L	T	P	Credits
-	-	4	2

1. To study different graphical tools for method study.
2. To draw flow process chart on different activities in Workshop/Laboratory/Office.
3. Computation of sales forecasting techniques and validation.
4. To conduct time study of bulb holder assembly operation of existing method.
5. Exercise on time study in athletic ground for 4\*100 m relay.
6. Exercise on performance rating to compute standard time for job.
7. Exercise on drawing String Chart by taking real time problem.
8. Sample exercise on ergonomic application.

**Course Title: Robotics**

**Paper Code: MEC705**

**Objectives:**

- To impart exposure to basic robot configurations, sensors, actuators.
- To impart knowledge about kinematics/ dynamics, control and programming of robots.

L	T	P	Credits
4	-	-	4

### UNIT-A

**Introduction to Robotics:** Introduction to automation and types, Robot definition, Brief history, Classification of Robots on the basis of configuration and other aspects, Control Method of teaching etc, specifications of robot systems, spatial resolution, accuracy, repeatability, Robot anatomy, work volume, drive systems, power transmission system, Joint notation scheme, control systems, Robot end effectors, Mechanism of operation, Mechanical and other types of grippers, tools as end effectors, End effectors interface.

### UNIT -B

**Robot Actuators Sensors and Controllers:** Actuator and drive elements, hydraulic, pneumatic and electrical drives, Criteria for selection of drives, Sensors like displacement, proximity and range sensors, touch, force sensors, machine vision etc, Robot cell layouts, design of work cells and control, Proportional, integral, derivative, PID control, robot as a work cell controller, use of interlocks.

### UNIT -C

**Kinematics and Dynamics:** Coordinate Frames, Mapping and Transformation, Forward kinematics of robots, D-H algorithm, solution of problems using D-H algorithm, Introduction to inverse kinematics, Existence of solutions, Uniqueness of solutions, solutions techniques, Acceleration of a rigid body, mass distribution, Newton's equation, iterative Newton Euler dynamic formulation, Lagrangian formulation of manipulator dynamics.

### UNIT -D

**Programming and Applications:** Methods of robot programming, Leadthrough programming, Motion interpolation, use of branching, Textual robot languages, structure, motion commands, speed control, end effector and sensor commands, Application of robots in industrial environments such as in assembly, welding, spray painting, machine loading and unloading etc.



## References:

- 1) S.R. Deb, *Robotics Technology and flexible automation*, Tata McGraw-Hill Education., 2009
- 2) Mikell P Groover& Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, *Industrial Robotics, Technology programming and Applications*, McGraw Hill, 2012
- 3) Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, *Robotics Engineering an Integrated Approach*, Phi Learning.,2009.
- 4) Mittal and Nagrath, *Robotics and control*, , Tata McGraw Hill, 2010
- 5) Francis N. Nagy, AndrasSiegler, *Engineering foundation of Robotics*, Prentice Hall Inc., 1987.

**Course Title: Advanced Mechatronics**

**Paper Code: MEC 702**

**Objective:**

L	T	P	Credits
4	-	-	4

- To introduce the students with the sensor technology, signal conditioning, digital electronics and control systems.
- To learn how to apply the principles of Mechatronics and automation for the development of productive and efficient manufacturing systems.
- To study the hydraulic and pneumatic systems employed in manufacturing industry.
- To learn the CNC technology and industrial robotics as applications of Mechatronics in manufacturing automation.

### UNIT - A

**Introduction:** Definition of Mechatronics. Mechatronics in manufacturing, products and design. Review of fundamentals of electronics. Digital Electronics: Digital logic, number systems, logic gates, Boolean algebra, Karnaugh maps, sequential logic. Data conversion devices, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers.

**Sensor Technology:** Sensor and transducers, terminology, displacement, position, proximity - encoders, velocity – tacho generators, force - strain gauges, pressure, temperature-thermocouples, RTDs, thermistors, light sensors - photoelectric sensors, IR sensors, sensor selection.

### UNIT - B

**Signal Conditioning & Data Presentation System:** Introduction D-A and A-D converters, operational amplifier, protection, filtering, Wheatstone Bridge, digital signals, multiplexers, data acquisition, digital signal processing, pulse-modulation, Data presentation systems- display, data presentation elements, magnetic recording, testing calibration, interface D-A and A-D converters.

**Precision Mechanical Actuation:** Pneumatic actuation systems, electro-pneumatic actuation systems, hydraulic actuation systems, electro-hydraulic actuation systems, mechanical systems, types of motion, kinematics, inverse kinematics, timing belts, ball screw and nut, linear motion guides, linear bearings, harmonic transmission, bearings, motor / drive selection.

### UNIT - C

**Drives:** stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.

Relays and solenoids, stepper motors, DC brushed and brushless motors, DC servo motors, AC / DC motors for non-servo motion drives, braking methods, pulse width modulated, Bipolar driver, Mosfet drives, SCR drives, variable frequency drives.

## UNIT - D

**Control System:** System transfer function, Laplace transformation and its applications, continuous and discrete processes, proportional control, integral control, differential control, PID control, digital controllers, control system performance, controller tuning, adaptive control, frequency response, PLC, PMC, Mechatronics design approach, possible mechatronics design solution for timed switch, wind screen, wiper motion, bathroom scale, pick and place robot, automatic camera, engine management system and bar code recorder. Introduction to MEMS, NEMS and nanotechnology.

### Recommended Books:

1. Kamm, *Understanding Electro-Mechanical Engineering - An Introduction to Mechatronics*. New Delhi: Prentice-Hall of India. Print.
2. Koren, *Computer Control of manufacturing system*. New Delhi: Tata McGraw Hill. Print.
3. Groover. *Production Systems and CIM*. New Delhi: PHI. Print.
4. Maleki, *Flexible Manufacturing systems*. New Delhi: Prentice Hall. Print.
5. Kuo, B.C. *Feedback Control Systems*. New Delhi: PHI. Print.
6. Boltan, W., *Mechatronics: electronic control systems in mechanical and electrical engineering*, Longman, Singapore, 1999.

**Course Title: Industrial Automation**

**Paper Code: MEC721**

L	T	P	Credits
4	-	-	4

**Objective:**After successful completion of the course, student will be able to

- To identify potential areas for automation and justify need for automation
- To select suitable major control components required to automate a process or an activity
- To translate and simulate a real time activity using modern tools and discuss the benefits of automation.
- To identify suitable automation hardware for the given application.
- To recommend appropriate modeling and simulation tool for the given manufacturing application.

**UNIT-A**

**Introduction:** Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines.

**UNIT -B**

**Automated Manufacturing Systems:** Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS, and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods, SPC Tools, Inspection Principles and Practices, Inspection Technologies.

**UNIT -C**

**Control Technologies in Automation:** Industrial Control Systems, Process Industries versus Discrete- Manufacturing Industries, Continuous Versus Discrete Control, Computer Process and its Forms.

**Computer Based Industrial Control:** Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules, and SCADA Systems & RTU.

**Distributed Control System:** Functional Requirements, Configurations & some Popular Distributed Control Systems.

**UNIT -D**

**Modeling and Simulation for Plant Automation:** Introduction, need for system Modeling, building Mathematical Model of a Plant, Modern Tools & Future Perspective. Industrial Control Applications: Cement, Thermal, Water Treatment & Steel Plants.

**References:**

- 1) Automation, Production Systems and Computer Integrated Manufacturing  
M.P.Grover, Pearson Education.5th edition, 2009.
- 2) Computer Based Industrial Control - Krishna Kant, EEE -PHI, 2nd edition, 2010.
- 3) An Introduction to Automated Process Planning Systems–TiesChiu Chang &Richard  
A. Wysk.
- 4) PerformanceModeling of Automated Manufacturing Systems, - Viswanandham, PHI,  
1<sup>st</sup> Edition, 2009.

**Course Title: Advance Materials**

**Paper Code: MEC775**

**Objectives:**After successful completion of the course, student will be able to:

L	T	P	Credits
4	0	0	4

- Understand the different materials used industries
- Heat treatment of the materials
- Properties of the different materials

#### **UNIT-A**

**Non-Ferrous Materials:** Copper and its Alloys, Aluminum and its Alloys, Nickel and its Alloys, Zinc and It's Alloys, Titanium and its Alloys, Magnesium and its Alloys, Cobalt and its Alloys, Lead and its Alloys

#### **UNIT -B**

**Ferrous Materials:** Production of Iron and Steel, Cast Irons, Low Alloy and High Alloy Steels, Tool Steels, Stainless Steels, Iron Carbon System, Time Temperature Transformation Relations, Heat Treatment of Plain Carbon Steels, Selective and Surface - Hardening

#### **UNIT -C**

**Polymers, Composites and Ceramics:** Polymer Materials (Introduction), Polymer Structure, Thermoplastics, Thermosets, Elastomers, Types and Applications of Ceramics, Properties of Ceramics Materials, Glass, Cements, Refractories and Advanced Ceramics, Structure of Composites, Metal Matrix Composites, Ceramic Matrix Composites, Polymer Matrix Composites, Fiberglass, Carbon Fibre Reinforced Polymer Composites, Properties of Composites

#### **UNIT -D**

**Miscellaneous Materials:** Smart Materials, Shape Memory Phenomenon and Alloys, Hydrogen Storage Alloys, Functionally gradient material, Adhesives, Metals for Nuclear energy, Sound Insulating Materials

#### **References:**

1. William F. Smith, HavadHashemi and Ravi Prakash, "Material Science and Engineering", Tata McGraw Hill Education (P) Ltd, 2013.
2. William D. Callister, Jr. and Balasubramaniam, R., "Callister's Material Science and Engineering", Wiley India (P) Ltd, 2009.
3. Gandhi and Thompson, "Smart Materials and Structures", Chapman and Hall, 1992.
4. Gladius Lewis, "Selection of Engineering Materials" Prentice Hall, 1989.
5. Rama Rao, "Advances in Materials and their applications", Wiley Eastern Ltd, 1993

**Course Title: Computer Integrated Manufacturing System**

**Paper Code: MEC703**

L	T	P	Credits
4	-	-	4

**Objective:**In this course, the student will

- Develop an understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques.
- Obtain an overview of computer technologies including computers, database and data collection, networks, machine control, etc, as they apply to factory management and factory floor operations.
- Describe the integration of manufacturing activities into a complete system
- Acquire sensitivity to human-factors related issues as they affect decision making in the factory environment.

**UNIT-A**

Introduction, Automation definition, Types of automation, processing in manufacturing, Production concepts, CIM wheel, evolution of CIM, Financial justification of CIM, Challenges and trends, Benefits of CIM, Fundamentals of computer technology, need of CIM. NC, CNC, DNC, FMC, Management of CIM, Impact of CIM on personnel.

**UNIT -B**

FMS concept, Components, Layouts, planning and implementation, Tool Management systems-Tool monitoring, Work holding devices- Modular Fixturing, flexible Fixturing, flexibility, quantitative analysis of flexibility, application and benefits of FMS, automated material handling system –AGVs, Guidance methods, Automated storage and retrieval systems, computer aided quality control - objectives of CAQC, QC and CIM, contact, non-contact inspection methods, CMM and Flexible Inspection systems.

**UNIT -C**

Group technology, types of coding systems, production flow analysis, Benefits, Computer Aided Process Planning, Retrieval types of process planning, Generative type of process planning, Material requirement planning, Fundamental concepts of MRP inputs to MRP, Capacity planning.

**UNIT -D**

Data-Manufacturing , data, types, sources, Structure of data models, Data base and DBMS- requirement, RDBMS,Shop floor control, Data logging and acquisition, Automated data collection, control types, fundamentals of communication, communication matrix, network architecture.

## References:

- 1) Kant Vajpayee. S., 'Principles of Computer Integrated Manufacturing, Prentice Hall of India, 1999.
- 2) Radhakrishnan.P, Subramanyan. S, 'CAD/CAM/CIM, New Age Internationalpublishers, 2000.
- 3) David Bedworth, Computer Integrated Design and Manufacturing, TMH, New Delhi, I Edition 1999.
- 4) Ranky, Paul G., Computer Integrated Manufacturing, Prentice Hall International 1999.
- 5) M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing, Prentice Hall of India, New Delhi.



**Course Title: Casting and Welding Metallurgy**

**Paper Code: MEC777**

L	T	P	Credits
4	-	-	4

**Objective:** This course addresses

- The casting and welding metallurgy, and weld ability of stainless steels, aluminium and its alloys, and other nonferrous structural metals.
- The problems encountered in welding various metals and metal alloys

### UNIT-A

**Principles of Solidification part-I:** Nucleation kinetics, basic concepts in crystal growth and solidification, solidification of single phase alloy, solidification of eutectics, and solidification of peritectics.

**Principles of Solidification part-II:** Columnar to equiaxed transition, microsegregation and macrosegregation, behavior of insoluble particle at the solid or liquid interface, low gravity effect during solidification, interpretation and use of cooling curves.

### UNIT-B

**Entrainment:** Entrainment defects-bifilms, bubbles, extrinsic inclusions, entrainment processes-surface turbulence, oxide skins from melt charged materials, pouring, oxide lap defect I & II, oxide flow tube, micro jetting, bubble trails, furling and unfurling, deactivation of entrained films, soluble, transient films, detrainment, evidence of bifilms, importance of bifilms, four common population of bifilms.

### UNIT-C

**Structure and Properties of Weldment:** Structure of the weld metal, HAZ and its properties, absorption of gases by weld metal and their effect on the weld properties, gas metal and slag metal reactions.

**Welding of Steels:** Introduction to welding of plain carbon steels, effect of carbon content and alloying elements on weldability, Carbon equivalent, preheating and different ways of determining the preheating temperature.

### UNIT-D

**Weldment Cracking:** Introduction to hot and cold cracking, various factors that promote hot and cold cracking and its remedies.

**Post Weld Heat Treatment:** Need of PWHT, stress relief, annealing and tempering of welds.

**Weldability of Commonly used Engineering Materials:** Difficulties in welding of stainless steels, cast irons, aluminum and its alloys etc. Selection of welding process and procedure appropriate for these materials, welding of dissimilar metals.

**References:**

- 1) A.S.M., *ASM Metals Handbook on Casting*. New Delhi: ASM International. Volume 15.
- 2) Nadkarni, S.V., *Modern Arc Welding Technology*. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd. 2009. Print.
- 3) Linnert, *Welding Metallurgy Volume I and II*. AWS. 2010. Print.
- 4) Kou, S., *Welding Metallurgy, A Jhon Wiley and Sons, Inc., Publication Second Edition*
- 5) Richard L. Little., *Welding and Welding Technology*. New Delhi: McGraw Hill Education. 2017. Print.
- 6) A.S.M., *ASM Metals Handbook on Casting*. New Delhi: ASM International. 1992.
- 7) Campbell J., *The Complete Casting Handbook*. New York: Elsevier.

**Course Title: Organization Theory and Behavior**

**Paper Code: MEC781**

L	T	P	Credits
4	0	0	4

**Objective:**

- To provide basic knowledge of key approaches and Models relating to Organizational Behaviour.
- To understand ways of acting effectively and finding ways for controlling human behaviour.
- To apply different concepts relating to managing of conflicts, change, time and stress.

### **UNIT – A**

#### **Conceptual Framework for Organizational Behavior**

**Nature of Organizational Behavior:** Concept, Nature, Disciplines contributing to OB, Foundations of OB, Human behavior approach, OB Models.

#### **Foundation of Organizational Behavior**

### **UNIT –B**

#### **Individual Dimensions of Organizational Behavior**

**Nature of Human Behavior:** Caused or Autonomous, Process of behavior, Individual differences.

**Personality and Perception:** Concept, Personality theories, Personality development, Determinants of Personality, Personality and Behavior, Perceptual process, Perceptual selectivity, Perceptual organization, Interpersonal Perception.

**Learning, Attitudes and Values:** Concept, Component of learning process, Factors affecting learning, Learning and Conditioning theories, Theories of attitude formation, Factors in attitude formation, Attitude measurement, Attitude change, Method of attitude change, Factors affecting value formation, Types of values.

### **UNIT –C**

#### **Group Dimensions of Organizational Behavior**

**Interpersonal Behavior:** Nature, Transactional analysis, Level of self-awareness, Ego status, Life script, Life positions, Stroking, Psychological games.

**Group Dynamics:** Concept, Formal and Informal groups, Committee, Task force, Quality Circle, Theories of group formation, Significance and dealing with informal groups, Group behavior, Norms, Cohesiveness, Decision making, Techniques of improving group decision making, Inter group behavior.

**Organizational Conflicts:** Concept, Positive and Negative aspect of conflict, Individual level conflict, Goal conflict, Role conflict, Interpersonal conflict, Group level conflict, Organization level conflict, Conflict management.

## UNIT -D

### **Structural and Cultural Dimensions of Organizational Behavior**

**Design of Organization Structure:** Concept, Mechanism of designing structure, Departmentation, Bases of Departmentation, Span of Management, Delegation of Authority, Centralization and Decentralization.

**Forms of Organization Structure:** Line and Staff organization structure, Line and Staff conflict, Overcoming Line and Staff conflict, Types of organization structure.

**Organizational Climate and Culture:** Concept, Developing sound Organizational Climate, Participation and Organizational Climate, Morale, Organizational Culture, Socio- culture features of India and their impact.

### **References:**

- 1) L.M.Prasad, *Organisational Behaviour*. S.Chand Publications. Print.
- 2) Stephen P. Robbins, *Organizational Behaviour*. Pearson Publications. Print.
- 3) Ahuja, K.K. *Organization Behaviour*. Kalyani Publishers. Print.
- 4) Schermerhorn, Hunt and Osborn. *Organisational Behaviour*. John Wiley, 9th Edition, 2008. Print.
- 5) Udai Pareek. *Understanding Organisational Behaviour*. 2nd Edition. Oxford Higher Education. 2004. Print.
- 6) Mc Shane & Von Glinov. *Organisational Behaviour*. 4th Edition. McGraw Hill. 2007. Print.

**Course Title: Material Management**

**Course Code: MEC782**

**Objective:**

- To teach the applications of various material management techniques for a variety of problems occurring in daily life.
- Study of integrated approaches to material management.

L	T	P	Credits
4	-	-	4

### UNIT-A

**Integrated approach to materials management:** Introduction, materials productivity and role of materials management techniques in improved materials productivity. Cost reduction and value improvement, value analysis for right choice and rationalization of materials.

**Purchasing function:** Objectives, purchase requisitions, types of specification, centralized versus decentralized purchasing, timing of purchases. Purchasing research, identification of right sources of supplies. Make or buy decisions, vender selection and vender rating. Negotiations, purchase price analysis and price determination. Purchasing organization, procedures, forms, records and reports. Purchasing as a dynamic profession, transition to supply management.

### UNIT -B

**Inventory Management:** Inventory concepts, reasons for holding inventory, types of inventory, inventory reduction tactics. Inventory turnover ratio. Selective Inventory management: ABC, VED, and FSN analysis etc., identifying critical items with selective inventory management.

**Operating Policies:** Continuous review system, periodic review system, comparative advantages and disadvantages of continuous and periodic review systems, hybrid systems. Inventory management across the organization.

### UNIT -C

**Optimizing Inventory:** Assumptions for Wilson's lot size model, inventory costs, hidden costs, composition of costs, estimation of inventory related costs, lead time, stock out point, number of time periods, calculating Economic Order Quantity (EOQ), sensitivity analysis of EOQ model.

**Special Inventory Models:** Finite replenishment rate model, lot size models with planned backlogging, generalized model with uniform replenishment rate, inventory model with lost sales, quantity discount model, one period decisions. Determination of safety stock, service level and uncertainty in demand. Information systems for inventory management.

## UNIT -D

**Stores Management:** Introduction, stores functions, stores organization, stores systems and procedures, stores accounting and verification systems, stores address systems, stores location and layout, store equipment.

**Standardization and Codification:** Classification of materials. Codification, objectives of codification, essential features of codification system, Brisch and Kodak systems, colour coding systems. Standardization and variety reduction.

### Reference Books:

- 1) Arnold and Chapman "*Introduction to Materials Management*", Pearson Education Asia, Fourth Edition, (2001).
- 2) Narsimhan, Mcleavey&Billington, "*Production Planning & Inventory Control*", Prentice Hall of India, Second Edition (2003).
- 3) Dobler Donald W., Burt David N., "*Purchasing and Supply Management*", Tata McGraw Hill, Sixth Edition (2001).
- 4) Menon K S, "*Purchasing and Inventory Control*", Wheeler Publishing New Delhi, Third Edition (1997).
- 5) Krajewski L J and Ritzman L P, "*Operations Management*", Pearson Education Asia, Sixth Edition (2004).

**Course Title: Entrepreneurship**

**Course Code: MEC783**

**Objective:**

- Study of applications of various approaches of entrepreneurship.
- To study International entrepreneurship approaches.
- Case study

L	T	P	Credits
3	-	-	3

### UNIT-A

**Small Scale Industries:** Definition and types of SSI's; Role, scope and performance in national economy; Problems of small scale industries.

**Industrial Sickness:** Definition; Causes of sickness; Indian scenario, Government help; Management strategies; Need for trained entrepreneurs.

### UNIT -B

**Entrepreneurship Development Programmers':**Introduction, Origin of EDP's , Organizations involved in EDP's, Objectives of EDPs, Implementation of EDP's, Short comings of EDP's, Role in entrepreneurship development.

#### STEP

Introduction, Origin, Status in India, Success and failure factors, Govt. policies and incentives, future prospects in India.

### UNIT -C

**Business Incubation:**Introduction, Origin and development of business incubators in India and other countries, types of incubators, success parameters for a business incubator, Benefits to industries, institutes, government and society; future prospects. A few case studies (at least 2).

**Special Aspects of Entrepreneurship:**Entrepreneurship, Social entrepreneurship, International entrepreneurship, rural entrepreneurship, Community Development, Women entrepreneurship.

### UNIT-D

**Network Marketing:** Introduction, E-business, E-commerce, E-auction, A basic internet e-business architecture, A multi-tier e-business architecture.

## Reference Books:

- 1) Gupta,P.K., "*Strategic Entrepreneurship*" (Everest Publishing House), 2000.
- 2) Cleland David, "*Project Management – Strategic Design and Implementation*" (McGraw Hill). 5<sup>th</sup> Edition 2007.
- 3) Holl H David, "*Entrepreneurship-New Venture Creation*" (Prentice Hall of India). 1991.
- 4) Steed & Steed, "*Sustainable Strategic Management*" (Prentice Hall of India).
- 5) Kotler, "*Marketing Management*" (Prentice Hall of India),2015.
- 6) Khalil Tarek, "*Management of Technology*" (McGraw Hill),1999.
- 7) Steiner Henry, "*Engineering Economic Principles*" (McGraw Hill), 2<sup>nd</sup> Edition,1996.



**Course Title: Management Information Systems**

**Paper Code: MEC784**

**Objective:**

- To understand the importance of information in business
- To know the technologies and methods used for effective decision making in an organization.

L	T	P	Credits
4	0	0	4

### **UNIT-A**

**Introduction:** Data, Information, Intelligence, Information Technology, Information System, evolution, types based on functions and hierarchy, System development methodologies, Functional Information Systems, DSS, EIS, KMS, GIS, International Information System.

### **UNIT-B**

**System Analysis and Design:**Case tools - System flow chart, Decision table, Data flow Diagram (DFD), Entity Relationship (ER), Object Oriented Analysis and Design (OOAD), UML diagram.

### **UNIT-C**

**Database Management System:**DBMS –HDBMS, NDBMS, RDBMS, OODBMS, Query Processing, SQL, Concurrency, Management, Data warehousing and Data Mart.

### **UNIT-D**

**Security Control and Reporting:**Security, Testing, Error detection, Controls, IS Vulnerability, Disaster Management, Computer Crimes, Securing the Web, Intranets and Wireless Networks, Software Audit, Ethics in IT, User Interface and reporting.

**New IT Initiatives:**Role of information management in ERP, e-business, e-governance, Data Mining, Business Intelligence, Pervasive Computing, Cloud computing, CMM.

### **Textbooks:**

1. Robert Schulte's and Mary Summer, Management Information Systems –The Managers View, Tata McGraw Hill, 2008.
2. Kenneth C. Laudon and Jane Price Laudon, Management Information Systems, Managing the digital firm, PHI Learning / Pearson Education, PHI, Asia, 2012.

**Reference:**

- 1) Rahul de, MIS in Business, Government and Society, Wiley India Pvt Ltd, 2012.
- 2) Gordon Davis, Management Information System: Conceptual Foundations, Structure and Development, Tata McGraw Hill, 21st Reprint 2008.
- 3) Haag, Cummings and McCubbrey, Management Information Systems for the Information Age, McGraw Hill, 2005. 9th edition, 2013.
- 4) Jawadegar, "Management Information System", TMH.
- 5) Raymond McLeod and Jr. George P. Schell, Management Information Systems, Pearson Education, 2007.
- 6) James O'Brien, Management Information Systems Managing Information Technology in the E-business enterprise, Tata McGraw Hill, 2004.
- 7) Ralph Stair and George Reynolds, Information Systems, Cengage Learning, 10th Edition, 2012.

**Course Title: Industrial Psychology**

**Paper Code: MEC785**

**Objective:**

- To understand the scope & Objective of Industrial Psychology.
- To get knowledge about recruitment, selection, training and development etc.
- To aware about employee stress management and health related issues.

L	T	P	Credits
4	0	0	4

### **UNIT- A**

**Introduction to Industrial Psychology:** Introduction, Major Fields of Industrial Psychology, Basic Concepts and Characteristics of Industrial Psychology, Methods of Industrial Psychology, Importance of Industrial Psychology, Industrial Psychology and India.

**Job Satisfaction and Motivation:** Introduction, Morale, Motivation at Work, Motivation Theories, Job satisfaction, measuring job satisfaction

### **UNIT - B**

**Leadership and Group Dynamics:** Introduction, Leadership vs Management, Leadership styles, Approaches of Leadership, Power and Politics in an organization, Ethics, values for managers, Corporate social responsibility, Group dynamics, Formal and informal groups, Teams.

**Stress Management:** Introduction, Stress and its types, Levels of Stress, Managing Stress, Organizational consequences of stress, Steps to be followed in stress management

### **UNIT - C**

**Maintaining Healthy Environment:** Introduction, Environment for work, Engineering psychology and Ergonomics, Boredom, Fatigue, Monotony, Relieving Boredom, Fatigue and Monotony, Industrial accidents, Factories Act 1948.

**Training and Development:** Introduction, Need and Rationale of Training, Meaning and Nature of Training and Development, Importance of Training, Training Methods, Designing Training, Management Development Techniques, The strategic role of executive development.

### **UNIT - D**

**Job Analysis:** Introduction, The Concept of Job, Position, Occupation and career, Objectives of Job Analysis, Types of Job Analysis, Purpose of Job Analysis, The process of Job Analysis, Job Analysis: Recent developments, Job Descriptions, Job Specifications, Job design, Approaches to job designing, Techniques of Job design, Job analysis in "Jobless" world.

**Recruitment and Selection: Reliability and Validity of Recruitment Tests:** Introduction, Purpose of Recruitment, Nature and Objectives of Recruitment, Sources of

Recruitment, Recruitment Procedure, Retention of Employees, The realistic job preview, Selection, Selection Tests, Group Discussion.

**References:**

1. Singh Narendar, *Industrial Psychology*. McGraw Hill. Print, 2011.
2. Spector, *Industrial and Organizational Psychology*. Wiley. Print. 6<sup>th</sup> Edition 2012.
3. Blum and Naylor, *Industrial Psychology*. CBS Publishers. Print. 2003.
4. Frank and Jeffrey, *Work in 21<sup>st</sup> Century, Introduction to Industrial and Organizational Psychology*. Wiley. Print. 4<sup>th</sup> Edition 2013.

**Course Title: Computer Control of Machine Tools**

**Paper Code: MEC 711**

L	T	P	Credits
4	-	-	4

**Objective:** The aim of this course is to

- Teach the applications of various Computer Numerical Control Machines.
- Computer Aided Manufacturing- Processes, Operations.
- Design and Operational Characteristics of Key Hardware Components and Programming Techniques.
- Merits and Demerits of Computer Numerical Controlled (CNC) Machines.

### UNIT-A

**Elementary Concepts in Numerical Control:** Requirement of Machine Tools and its Advantages over Conventional Manufacturing. Structure of NC System Economics of NC for m/c tools, Constructional details of N.C. m/c tools, MCU Structure and Functions, Technique and Procedure of Recuperating Accuracy and Productivity using NC.

### UNIT -B

**Machine Actuation and Control:** Numerical Control Machine Actuation and Control Drives, Feedback Devices, Counting Devices, DAC and ADCs Interpolator systems along with the Optical, Pneumatic, Hydraulic, Electro- Mechanical and Electromagnetic Control Systems. Control Loop Circuit Elements in PTP system, Contouring System, Incremental and Absolute Systems, Definition and Designation of Control Axes, Tool and Zero Presetting, Work Holding and Setting up of NC M/c.

### UNIT -C

**CNC, DNC and Adaptive Control Systems:** Types and functions of Computer Numeric Control (CNC), Types and functions of Direct Numeric Control (DNC), Need of Adaptive Control Types, Functions and Types of Adaptive Control-its uses & benefits, Advantages of Combined CNC/DNC Systems. Control systems for Positional Control and Tool Changing Systems, Digital Computer and its Functioning for m/c control, Microprocessor in CNC.

### UNIT -D

**NC Part Programming:** NC part programming in FANUC system for Mechanical Components, Flexible Tooling, Tool Path Simulation on lathe and milling, Advanced Programming Features, Block Format and Codes, Tool Length and Radius Compensation, Computer Assisted Part Programming, the APT Language- Geometric, Motion, Post Processor and Auxiliary Statements.

## References:

1. Koren, Yoram, *Computer control of manufacturing systems*, McGraw Hill, Singapore, 1983.
2. Kundra, T.K., Rao, P.N., Tewari, N.K., *Numerical control and computer aided manufacture*, Tata McGraw Hills, New Delhi, 1993.
3. Pabla, S., Adithan, M., *CNC Machines*, Willey Eastern, New Delhi.
4. Thyer, G.E., *Computer Numerical Control of Machine Tools*, Industrial Press, Incorporated, USA.1988, Second Edition.

**Course Title: Tribology**

**Paper Code: MEC786**

**Course Objectives:**The students will learn about

- Types, principles and analysis of Friction, Wear and Lubrication.
- Various tests used in Tribology.

L	T	P	Credits
4	-	-	4

### UNIT - A

**Introduction:**Friction, wear and lubrication, types of engineering contacts: conforming and non-conforming, Types of motion: rubbing, sliding, oscillating, rolling, surface of interaction, elastic and plastic deformations, properties of materials, surface energy and flash temperature theory.

**Friction:**Laws of sliding friction, concept of adhesion, Tabor's model of elastic thermo friction, rolling friction, measurement of friction.

### UNIT - B

**Wear:**Laws of wear, types of wear such as adhesive, declamation, abrasive, corrosive, fretting, erosive and oxidative. Measurement of wear and friction in atmosphere and different environments, Prevention and control of wear and friction in machines, wear of cutting tools and dies, study of abrasion in grading, lapping/ honing

**Lubrication:**Mechanism of lubrication, Boundary, squeeze film hydrodynamic and elasto hydrodynamic and hydrostatic lubrication, plasto hydrodynamic lubrication, solution of Reynolds's equation in two and three dimensional flow, pressure distribution load carrying capacity friction forces in oil film and coefficient of friction in journal bearing, Solid, Liquid and Gas lubricants types and their applications

### UNIT - C

**Bearing Design:** Design of bearing, clearance in journal bearing, minimum film thickness, sommar field number, oil grooves and flow of oil in axial and circumferential grooves cavitation's and turbulence in oil bearings, Heat generation and cooling or bearing hydrostatic and dynamic and their applications in machine tools, Design of air bearings and other gas bearings.

**Rolling Friction:**Reynold slip, Heathe cote concept selection of roller bearings and their methods of lubrication design aspects and modes of bearing failures and elasto hydrodynamic lubrication.

### UNIT - D

**Tests and Instrumentation in Tribology:** Sliding friction and wear abrasion test, rolling contact and fatigue test, solid particle and erosion test, Corrosion test Special instruments for lubricant analysis such as optical and infrared spectroscopy and infra-red spectroscopy, atomic absorption and emission spectroscopy, mass spectroscopy, NMR spectroscopy, Xray-diffraction and chromatographic techniques, Use of

transducers and instruments in Tribology- film thickness measurement using modern techniques – Development of test rigs for Tribology research.

## References

- 1) Bhusan Bharat. *Principles and Application of Tribology*. John Wiley & Sons, Ltd, 2013, Print.
- 2) SrivastvaSushilkumar. *Tribology in Industries*. S. Chand Publishing, 2001, Print.
- 3) Majumdar B.C. *Introduction to Tribology of Bearing*. S. Chand, 2008, Print.
- 4) Stachowiah G. W. and Batchelor, *Engineering Tribology*. Butterworth Heinemann, Oxford, 2005, Print.
- 5) Khonsari and Booser. *Applied Tribology: Bearing Design and Lubrication*. Wiley Publications, 2008, Print.
- 6) Gohar R., Rahnejat H., *Fundamentals of Tribology*, Imperial College Press, London, 2012, Print.



**Course Title: Maintenance and Reliability**

**Paper Code: MEC787**

**Objective:** This course aware the students on

- Various maintenance management processes.
- Students to acquire knowledge and technique in reliability engineering and equip students to make decision on sound maintenance and reliability engineering.

L	T	P	Credits
4	-	-	4

#### UNIT-A

**Reliability Engineering:** Reliability concepts and patterns of failure, Failure data, and reliability function, failure rate and hazard rate, Numerical.

**Common Distributions in Failure Mechanisms:** Exponential, Weibull, Gamma, Reliability expressions for constant, Increasing and Decreasing Hazard Rates. Data Analysis, Probability plots for various distributions- Normal, log normal, extreme value, model selection for components failure, failure analysis, Causes and types of failures.

#### UNIT-B

**Reliability Prediction and Analysis:** System reliability- series, parallel and mixed configuration, block diagram method, fault tree and success tree methods, event tree method, Numerical.

**Reliability Design:** Reliability improvement and allocation-Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability.

#### UNIT-C

**Maintenance Planning and Replacement:** Maintenance planning – Overhaul and repair; Meaning and difference, Optimal overhaul/Repair/Replace maintenance policy for equipment subject to breakdown, Replacement decisions – Optimal interval between preventive replacements of equipment subject to breakdown, group replacement..

**Maintenance Systems:** Fixed time maintenance, Condition based maintenance, Opportunity maintenance, design out maintenance, Total productive maintenance, Inspection decision – Optimal inspection frequency, non-destructive inspection, PERT & CPM in maintenance, Concept of terotechnology.

#### UNIT-D

**Condition Monitoring:** Techniques-visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, Crack monitoring, Thickness monitoring, Noise and sound monitoring, concept of S/N ratio, Condition monitoring of hydraulic system, Machine diagnostics - Objectives, Monitoring strategies, Examples of monitoring and diagnosis.

**Safety Aspects:** Importance of safety, Factors affecting safety, Safety aspects of site and plant, Instruments for safe operation, Safety education and training, Personnel safety, Disaster planning and measuring safety effectiveness, Future trends in industrial.

**References:**

- 1) Manna, A., *A Textbook of Reliability and Maintenance Engineering*. New Delhi: I.K. International.
- 2) Khanna, O.P., *Industrial Engineering and Management*. New Delhi: Dhanpat Rai and Sons. 1994. Print.
- 3) Kelly, A., *Maintenance Planning and Control*. Butters worth & Co. 1984. Print.
- 4) Srivastava, S.K., *Industrial Maintenance Management*. New Delhi: S. Chand & Co. Ltd. 2017. Print.
- 5) Gupta, A.K., *Reliability Engineering and Technology*. New Delhi: Macmillan India Ltd. 1996. Print.
- 6) Dhillon, B.S., *Reliability, Quality and Safety Engineering*. London: CRC Press.

**Course Title: Optimization Techniques**

**Paper Code: MEC788**

**Objective:**After successful completion of the course, student will be able to

L	T	P	Credits
4	-	-	4

- understand importance of optimization of industrial process management
- apply basic concepts of mathematics to formulate an optimization problem
- analyses and appreciate variety of performance measures for various optimization problems

### UNIT-A

**Introduction to Optimization Techniques:** Operation Research approach, scientific methods, introduction to models and modeling techniques, methodology and advantages of optimization techniques.

**Duality in Linear Programming, Integer Linear Programming:** Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, two phase method.

**Sequencing:** Introduction, processing N jobs through two machines, processing N jobs through three machines, processing N jobs through m machines.

### UNIT -B

**Inventory Model:** Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount.

**Network Analysis:** Network definition and Network diagram, probability in PERT analysis, project time cost trade off, introduction to resource smoothing and allocation.

### UNIT -C

**Queuing Models:** Concepts relating to queuing systems, basic elements of queuing model, role of Poisson & exponential distribution, concepts of birth and death process.

**Replacement & Maintenance Models:** Replacement of items, subject to deterioration of items subject to random failure group vs. individual replacement policies.

**Non Linear Programming** –One and Multi Variable Unconstrained Optimization, Kuhn-Tucker, Conditions for Constrained Optimization, Quadratic Programming, Separable Programming Convex programming. Non Convex Programming

### UNIT -D

**Simulation:** Introduction & steps of simulation method, distribution functions and random number generation.

**Introduction to Various Evolutionary Optimization Techniques:** i.e. Generic algorithm, NSGA, NSGA-II, Neural Network, Ant colony optimization, Particle swarm optimization etc.

## References:

- 1) Taha, H. A. Operations Research -An Introduction (8<sup>th</sup> edition). New York: Macmillan Publishing Co. 2006.
- 2) Swarup, K., P. K. Gupta and M. Mohan. Operations Research. New Delhi: Sultan Chand & Sons, 2001.
- 3) Hadly, G. Non-Linear and Dynamic Programming. New Delhi: Addison Wesley, Reading Mass. 1967.
- 4) Rao, S. S. Optimization theory and Applications (4<sup>th</sup> edition). New Delhi: Wiley Eastern Ltd. 2009.
- 5) Hagan. T. Howard B. Neural Network Design 2<sup>nd</sup> Edition.
- 6) D. Kalyanmoy. Multi-Objective Optimization Using Evolutionary Algorithms First Edition.

**Course Title: Business Policy and Strategies**

**Course Code: MEC789**

**Objective:**

- To teach the different approaches and strategies used in business.
- To framework new policies in business.

L	T	P	Credits
3	-	-	3

### **UNIT-A**

**Introduction:** Definition, nature, scope, and importance of strategy; and strategic management (Business policy). The Strategic management model, Benefits of strategic management.

**Strategy Formulation:** Vision and Mission statements, Importance, Characteristics and components of Mission statement.

**Environmental Appraisal:** Concept of environment, components of environment (Economic, legal, social, political and technological). Environmental scanning techniques-ETOP, QUEST and SWOT (TOWS).

### **UNIT -B**

**The external assessment:** Economic forces, Technological Forces, Competitive forces  
Competitive Analysis: Porters Five Force Model

**The Internal Assessment:** Integrating Strategy and culture, Management, Finance, productions/ Operations, Research and Development, management Information System, value Chain, Evaluation matrix.

### **UNIT -C**

**Strategies in Action:** Objectives Types of Strategies, Integration Strategies, Intensive Strategies, Diversification Strategies, Defensive Strategies, Defensive strategies.

**Strategy Analysis and Choice:** Nature, Frame Work of strategy analysis and choice, Input stage, matching stage, Decision stage.

### **UNIT -D**

**Strategy Implementation:** Policies, Resource allocation, Managing Conflicts, managing Resistance to change, Leadership and corporate culture, Values, Ethics and Strategic control and operational Control. Organizational systems and techniques of strategic evaluation.

### **Recommended Text Books**

- 1) Kazmi, "*Business Policy & Strategic Management*" Tata McGraw Hill.
- 2) Thomson & Strickland, "*Strategic Management: Concept & Cases*" Tata McGraw Hill.
- 3) Ghemawat, "*Strategy & The Business Landscape*" Pearson Education Asia.
- 4) Ghoshal, Piramal, "*World Class in India*" Penguin Publishers.
- 5) Wheelen & Hungee, "*Strategic Management & Business Policy*" Addison-Wesley.
- 6) Pearce & Robinson, "*Strategic Management*" AITBS New York.

**Course Title: Instrumentation and Control Engineering**

**Paper Code: MEC 790**

L	T	P	Credits
4	-	-	4

**Course Objectives:** Students will learn about:

- Basic concepts of control engineering, its instrumentation
- Sensors signal transmission,
- Transfer functions of mechanical, electrical, pneumatic and hydraulic systems, its graphical methods.

### UNIT-A

**Introduction:** Review of basic principles of measurement & process control systems; Elements of instrumentations.

**Instrumentation System Elements:** Introduction, displacement sensors, speed sensors, fluid pressure sensors, fluid flow, liquid level, temperature sensors, sensor selection, signal transmission.

### UNIT-B

**Measurement:** Principles of dynamic measurement; Transducers, amplifiers and recording systems; measurement of physical variables, i.e. motion, strain, force, torque, temperature, pressure and flow etc. Principles of optical, eddy current based and ultrasonic's based measurement devices for metrological applications; Interferometers; Principles of Holography; Calibration its importance and general principles.

### UNIT-C

**Control Systems:** Concepts, Controller characteristics. Transfer functions of mechanical, electrical, pneumatic and hydraulic systems; Transients and frequency response; types of control action. Cascade control, feed-forward control, digital control system, control networks

**Process Controllers:** Introduction, on-off control, proportional control, derivative control, integral control.

### UNIT-D

**Stability:** Concept, criterion and determination by analytical and graphical methods Routh, Hurwitz, Bode and Niquist, Relative stability

## References:

- 1) Doebelin, *Measurement Systems*, McGraw Hill, New Delhi (Pub. at Singapore). July 2017.
- 2) Nagrath&Gopal, *Control System Engg*, 2<sup>nd</sup> Edition-1982.
- 3) Benjamin C. Kuo, *Automatic Control Systems*, Prentice Hall of India, New Delhi. 3<sup>rd</sup> Edition 1975.
- 4) Ogata.K, *Modern Control Engg.*, Prentice Hall of India, New Delhi. 5<sup>th</sup> Edition 2010.
- 5) Holman, *Experimental Methods for Engineers*, McGraw Hill, New Delhi. 2007.
- 6) Gupta & Syal, *Introduction to Metrology*, Dhanpat Rai & Sons, New Delhi.
- 7) D.S. Kumar, *Mechanical measurements*, Metropolitan, New Delhi. 4<sup>th</sup> Edition 2009.



**Course Title: Dissertation Phase-I**  
**Paper Code: MEC 795**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
0	0	12	6

As per policy document of DAV University, wide reference no. **DAVU/Regr/2016/2613**

**Course Title: Dissertation Phase-II**  
**Paper Code: MEC 796**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
0	0	24	12

As per policy document of DAV University, wide reference no. **DAVU/Regr/2016/2613**