

SEMESTER – III

21MN71 PROJECT WORK – I vide Automotive Engineering 21AE71

SEMESTER – IV

21MN81 PROJECT WORK – II Vide Automotive Engineering 21AE81

PROFESSIONAL ELECTIVES

21MN21 LEAN SIX SIGMA IN MANUFACTURING AND SERVICE

3 0 0 3

CONCEPTS OF LEAN SIX SIGMA: Lean Principles, eight major wastes; Six-Sigma: Concept, methodology, definition, origin, common terms; Five laws of lean six sigma, Methodology - DMAIC, DMADV, Project selection; Six Sigma roles and responsibilities; Six sigma training plan; Team: stages, characteristics of effective teams, Lean Six-sigma (LSS) metrics: DPMO calculation; Quality cost: cost of poor quality, cost of quality; Roadmap for implementation: Plan, issues, management strategies. (10)

DEFINE AND MEASURE PHASES: Customer identification, voice of customer (VOC), VOC data collection, Critical to quality (CTQ); Value Stream Mapping; SIPOC; Project charter; Types of measures; Types of data; Applications of old and new 7 QC tools; Measurement system analysis; Process capability analysis, comparison of statistical softwares; Introduction to Data analytics. (12)

ANALYSE PHASE: Inferential and Descriptive Statistics; Patterns of Variation; Normality Analysis using python, multi-vari analysis; Hypothesis testing for Normal Data: Selection and application problems; Failure mode and effects analysis - applications; Analysis of Lean Wastes. (11)

IMPROVE AND CONTROL PHASES: Process redesign principles; Generating improvement alternatives; Quality Function Deployment (QFD); Theory of Inventive Problem Solving (TRIZ); Introduction to design of experiments; Lean waste elimination methods, cycle time reduction; Cost/benefit analysis; Process scorecard: Control Plan. Introduction to IoT data acquisition. (12)

Total L: 45

REFERENCES:

1. Jay Arthur, "Lean Six Sigma – Demystified", Tata McGraw Hill Companies Inc, 2011.
2. Juran Institute, Juran Global's Lean and Six Sigma Reference Guide and Tool Kit, CreateSpace Independent Pub, 2014.
3. Robert Dirgo, "Look Forward Beyond Lean and Six Sigma", Cengage Learning, 2014.
4. Anil Maheswari, "Data Analytics", McGraw-Hill Education, 2017.
5. Thomas Pyzdek, "Six Sigma Handbook: Complete Guide for Greenbelts, Blackbelts and Managers at All Levels", Tata McGraw Hill Companies Inc, 2003.
6. Donald W Benbow and Kubiak T M, "Certified Six Sigma Black Belt Handbook", Pearson Education, 2007.

21MN22 LOGISTICS STRATEGIES AND DISTRIBUTION MANAGEMENT

3 0 0 3

LOGISTICS, DISTRIBUTION AND PLANNING FOR LOGISTICS: Introduction to logistics and distribution- Integrated logistics and the supply chain- Integrated logistics and the supply chain- Customer service and logistics- Channels of distribution – Key issues and challenges for logistics. Planning framework for logistics -Logistics processes -Supply chain segmentation- Logistics network planning - Logistics management and organization - Manufacturing and materials management. (12)

WAREHOUSING AND STORAGE: Principles of warehousing Storage and handling systems (palletized and non-palletized) – Order picking and replenishment- Receiving and dispatch - Warehouse design- Warehouse management and information. (11)

FREIGHT TRANSPORT AND OPERATIONAL MANAGEMENT: International logistics: modal choice - Maritime transport - Air transport - Rail and intermodal transport- Road freight transport: vehicle selection, vehicle costing and planning and resourcing – International transportation systems in Global perspective. Cost and performance monitoring- Benchmarking- Information and communication technology in supply chain- Outsourcing: services and decision criteria, the selection process – Outsourcing management- Security and safety in distribution - Logistics and the environment. (12)

MAINTENANCE LOGISTICS: Human factors – Maintenance staffing: Learning curves – Simulation – Maintenance resource requirements: Optimal size of service facility – Optimal repair effort – Maintenance planning and scheduling – Spare parts planning. (10)

REFERENCES:

1. Alan Rushton, Phil Croucher and Peter Bake, "The Handbook of Logistics and Distribution Management", Kogan Page, 6th Edition, 2017.
2. Jean-Paul Rodrigue, Claude Comtois and Brian Slack, "The geography of transport systems", New York, 3rd Edition, 2013.
3. Andrew K.S. Jardine, and Albert H.C. Tsang, "Maintenance, Replacement and Reliability", Taylor and Francis, 2006.
4. Bikas Badhury, and S.K. Basu, "Tero Technology: Reliability Engineering and Maintenance Management", Asian Books, 2003.
5. Seichi Nakajima, "Total Productive Maintenance", Productivity Press, 1993.
6. Donald Waters, "Global Logistics and Distribution Planning: Strategies for Management", Kogan Page, 2003.

21MN23 COSTING AND PRODUCT ANALYSIS**3 0 0 3**

ELEMENTS OF COSTING: Elements of cost – estimation – differences – types of costing – cost classification – depreciation – different methods; Types of cost: Labour cost – direct, indirect - labour variances - material cost - direct, indirect - material cost variances with examples, overhead cost. Elements in over heads, machine hour rate, apportioning methods - variance – examples (11)

ACTIVITY BASED COSTING AND TARGET COSTING: Introduction - traditional approach, comparison- examples– activity-based management; introduction to target costing, market driven, product driven and component driven target costing. (10)

COST CALCULATION AND ANALYSIS: Cost calculation for machined components, welding, casting and forged components plastic molded, powder metallurgy parts – illustrations – calculation of sales cost- cost of refection – case studies – use of computers in cost estimation; Cost analysis techniques: Analytical, graphical and incremental methods for single and multi-variable situations – learning curves. (12)

PRODUCT DEVELOPMENT AND PROCESS SELECTION: New products, new product strategy - market definition, idea generation - introduction to the design process – quality function deployment - forecasting sales potential - product engineering and markets, monopoly, competitive; Manufacturing planning: Selection of optimum process, standardization. - Process capability analysis - break even analysis - application and area of use - problems - multi - product analysis. (12)

Total L: 45**REFERENCES:**

1. Glen L Urban and John R Hauser, "Design and Marketing of New Products", Prentice Hall, New Jersey, 2004.
2. Banga T R, Sharma S C, "Mechanical Estimating and Costing (Including Contracting and Process Planning)", Khanna Publishers, 2015.
3. Kannappan D, Ag Augustine, Paranthaman D, "Mechanical Estimating and Costing", Tata McGraw Hill, New Delhi, 2003.
4. Narang G B S and Kumar V, "Production and Costing", Khanna Publishers, Fourth edition, 2014.

21MN24 PROJECT MANAGEMENT**3 0 0 3**

PERCEPTION OF PROJECT MANAGEMENT: Defining project success, the talent triangle, roles of project stakeholders, classification of projects, concurrent engineering, evolution and elementary definitions of PM, causes of project failures, the stage-gate process, project lifecycles, methodologies of PM, systems thinking, types of organizational structures, seven impediments to PM maturity, organizational chart of a project, prevalent mistakes in PM, case studies on management functions and communications management. (11)

CONFLICT RESOLUTION AND PLANNING: Types of conflicts - superior, subordinate, and functional; modes of resolution, case studies on conflict handling and resolution, Variables in PM - predicting project success, best practices adopted in PM; Planning – business case, assumptions and objectives, lifecycle phases and milestones, project specifications and selection, management cost and control system, work planning authorization, project plan, charter, verification and validation, audits. (10)

SCHEDULING, COSTING AND METRICS: Fundamentals of network, Graphical Evaluation and Review Technique (GERT), dependencies, slack time, network replanning, PERT/CPM and crash times, probabilistic schedules, variable time estimates, PERT beta and triangular models, precedence networks, probability of project completion, burn down and burn up charts, Gantt Chart, Pertmaster Metrics; PM software; Pricing and Estimates – pricing strategies, types of estimates, systems pricing, life-cycle costing, the time value of money and discounted cash flow, Net Present Value (NPV), Internal Rate of Return (IRR), comparing IRR, NPV, and payback; Cost control - the Earned Value Measurement System (EVMS), the cost overrun dilemma, case studies on cost control; Metrics - project management information systems, Key Performance Indicators (KPIs), value-based metrics. (16)

RISK, CONTRACTS AND QUALITY MANAGEMENT: Certainty, risk, and uncertainty, risk management process, qualitative and quantitative risk analysis, responding, monitoring and controlling risk; Contracts – Procurement planning, types of contracts vs risks; Quality management – concepts, the cost of quality, the seven quality control tools, the Project Management Maturity Model (PMMM); Case studies on project delays and successful project completions. (8)

Total L: 45

REFERENCES:

1. Erik Larson and Clifford Gray, "Project Management: The Managerial Process", McGraw-Hill Education, 8th Edition, 2020.
2. Te Wu, "Optimizing Project Management", CRC Press, 1st Edition, 2020.
3. Pradeep Pai, "Project Management", Pearson Education, 1st Edition, 2019.
4. Gary L. Richardson and Brad M. Jackson, "Project Management Theory and Practice", CRC Publications, 3rd Edition, 2019.
5. Robert KWysocki, "Effective Project Management: Traditional, Agile, Extreme", John Wiley and Sons, 8th Edition, 2019.
6. Harold Kerzner, "Project Management: A Systems Approach to Planning, Scheduling, and Controlling", John Wiley and Sons, 12th Edition, 2017.

21MN25 SEQUENCING AND SCHEDULING

3 0 0 3

SINGLE AND PARALLEL MACHINE SCHEDULING: Scheduling as a function and theory, scheduling problem, sequencing - objective, constraints, difference between sequencing and scheduling; Single machine models -Characteristics, terminology, theorems, SPT and EDD sequences, minimizing in - process inventory, mean flow time, weighted mean flow time, number of tardy jobs and mean tardiness, Hodgson's algorithm, Wilkerson -Irwin algorithm, applications of dynamic programming and branch and bound techniques, minimizing total cost, non-simultaneous arrivals, dependent jobs, sequence dependent set up time, use of assignment model, heuristic solutions; Parallel Machine Models -Minimizing make span, independent jobs- McNaughton's algorithm, heuristic procedures, minimizing weighted mean flow time, jobs- Hu's algorithm, Muntz-Coffman algorithm. (12)

FLOW SHOP AND JOB SHOP SCHEDULING: Flow shop-Permutation schedule, Johnson's problem, branch and bound algorithms, dominance properties for make span problems, heuristic approaches, flow shops without intermediate queues, other performance measures; Job shop -Types of schedules, schedule generation - branch and bound approach, heuristic procedures, integer programming approach. (11)

RESOURCE CONSTRAINED PROJECT SCHEDULING AND SIMULATION: Extending job shop model - extending project model, integer programming approach - heuristic methods; Project Scheduling -Logical constraints, network constructions, temporal analysis, probabilistic network analysis, time/cost trade-off, resource allocation; Simulation -Elements of simulation models, reducing mean flow time, meeting due dates, case studies. (12)

RESOURCE SCHEDULING: Interval scheduling, reservations and timetabling -Reservation without slack, reservation with slack, timetabling with workforce, operator constraints - Case study; Planning, scheduling and timetabling in transportation - Tanker and aircraft scheduling, train scheduling; workforce scheduling -Day-off scheduling, shift scheduling- cyclic staffing problem, operator scheduling in a callcenter. (10)

Total L: 45

REFERENCES:

1. Baker K, "Introduction to Sequencing and Scheduling", John Wiley and Sons, 2009.
2. Michael L Pinedo, "Planning and Scheduling in Manufacturing and Services", Springer Science and Business Media, 2009.
3. Dileep R. Sule, "Production Planning and Industrial Scheduling", CRC Press, 2007
4. Richard Walter Conway, William L. Maxwell, Louis W. Miller, "Theory of Scheduling", Addison-Wesley, Mass., 2003.

21MN26 VALUE ENGINEERING

3 0 0 3

CONCEPTS OF VALUE ENGINEERING (VE): Introduction, types of values, types of functions, function identification, feature function matrix, function analysis; Elements of costs, cost allocation to functions. Worth analysis: Meaning and importance of worth, evaluation of worth, guide lines to find worth. (11)

TECHNIQUES OF VE: General tools: Brain storming, Gordon technique, feasibility ranking, morphological analysis, ABC analysis, probability approach, make or buy decision; Special tools: Function-cost- worth analysis, FAST: technically oriented FAST, customer oriented FAST, weighted evaluation method. (11)

VE TEAM DYNAMICS: Team constitution, selection of team members; Team dynamics: team transformation, interpersonal relationship; Conduct of VE project study, task flow diagram, pre-study phase, workshop phase and post-study phase. (10)

VALUE ENGINEERING JOB PLAN: Orientation phase, information phase, speculation phase, analysis phase: evaluation of alternatives, cost benefit analysis, recommendation phase and implementation phase - operational and financial audit, applications of VE Job Plan. (13)

Total L: 45

REFERENCES:

1. Kassa A O, "Value Analysis and Engineering Reengineered", Taylor and Francis, 2016.
2. Mukhophadhyaya A K, "Value Engineering Mastermind: From Concept to Value Engineering Certification", Sage

- Publications Pvt. Ltd., New Delhi, 2014.
3. Del Younker, "Value Engineering Analysis and Methodology", 1st Edition, CRC Press, 2003.
 4. Richard J Park, "Value Engineering – A Plan for Invention", CRC Press, 1999.

21MN27 ENTERPRISE RESOURCE PLANNING

3 0 0 3

FUNDAMENTALS OF ERP SYSTEMS: ERP an overview, Enterprise an overview, ERP as integrated management information system; Evolution of ERP, benefits of ERP, ERP vs. traditional information systems; MRP II model. (10)

BUSINESS PROCESS REENGINEERING (BPR): Need and challenges, management concerns about BPR, BPR to build the business; Model for BPR, Basic constituents for BPR, and Selection criteria for BPR – Implementation of BPR based on the process, Methodology for implementing BPR. (10)

ERP PACKAGES: Analysis of ERP packages, survey of Indian ERP packages - coverage, performance and cost; Extended ERP (ERP II) -Advanced planning systems, business intelligent systems; IoT module for ERP system with Cloud computing – ERP case studies: Manufacturing and education domain. (12)

ERP IMPLEMENTATION: ERP – implementation, lifecycle, implementation methodology, hidden costs in implementation, Top management concerns, organizing the implementation, vendors, consultants and users, project management and monitoring, issues in customizing ERP systems for organizations, need for training; Functions of Finance & Costing – Materials Management, Production Planning, Human Resource, Plant Management, Quality Management, Sales and Distribution modules. (13)

Total L: 45

REFERENCES:

1. Alexis Leon, "Enterprise Resource Planning", Tata McGraw-Hill Publishing Company, 4th Edition, 2019.
2. Rajesh Ray," Enterprise Resource Planning Paperback", Tata McGraw-Hill Publishing Company, 2017.
3. Michael W. Pelphrey, "Directing the ERP Implementation: A Best Practice Guide to Avoiding Program Failure Traps While Tuning System Performance", CRC Press, 2015.
4. Alexis Leon," ERP Demystified", Tata McGraw-Hill Publishing Company, 3rd Edition, 2014.
5. Marianne Bradford, "Modern ERP: Select, Implement, and Use Today's Advanced Business Systems", 3rd Edition, 2014.

21MN28 HUMAN FACTORS AND ERGONOMICS

3 0 0 3

FOUNDATIONS OF HUMAN FACTORS ENGINEERING (HFE) AND POSTURAL ANALYSIS: Evolution of HFE, compatibility, Hawthorne experiments, sociotechnical systems theory, FMJ vs FJM trend, attempts to humanize work, Participative design of work equipment, case studies using HFE checklists and task analysis, risk assessment and design tools, Oxenburgh productivity model, case studies on ergonomics in industry, analysis of postural stability, risk factors for musculoskeletal injury, problems – whole body impact, collisions, shocks and spinal compression, measurement of musculoskeletal pain in the workplace. (12)

RELIABILITY AND HUMAN ERROR: Human-system integration, system variables, causes of human error and taxonomies, evaluation of human reliability, computational methods for human reliability analysis - THERP, SHERPA, TAFEI, HCR, ATHEANA, and CREAM, human information processing model. (12)

ANTHROPOMETRY AND WORKSTATION DESIGN: Types of anthropometric data in ergonomics, statistical analysis of anthropometric variables, workstation design to fit a target population, cost benefit analysis and trade-offs, scaling techniques – RASH, design of workstation and customized products using anthropometric data, system integration. (12)

PERCEPTION, SAFETY AND ENVIRONMENTAL DESIGN: Display of visual, auditory, and tactual Information, occupational accident trends, structural risk heuristics, domino models, fault-tree analysis, Cusp catastrophe model, Swiss Cheese model of risk management, measures for accident prevention, design of micro and macro environments, theory of defensible space, sick building syndrome, initiation to OSHA, NIOSH and BIS ergonomic standards, case studies delineating remedial ergonomic intervention. (9)

Total L: 45

REFERENCES:

1. Robert S Bridger, "Introduction to Human Factors and Ergonomics", CRC Press, 2018.
2. Robert W Proctor, Trisha Van Zandt, "Human factors in simple and complex systems", CRC Press, 2018.
3. Stephen J Guastello, "Human Factors Engineering and Ergonomics: A Systems Approach", CRC Press, 2013.
4. Steven J Landry, Mark R Lehto, "Introduction to Human Factors and Ergonomics for Engineers, CRC Press, 2013.
5. Karl HE Kroemer, Hiltrud J Kroemer, Katrin E Kroemer-Elbert, "Engineering Physiology", Springer, 2020.
6. Andre Liem, "Prospective Ergonomics", Wiley, 2017.

21MN29 TOTAL PRODUCTIVE MAINTENANCE

3 0 0 3

FOUNDATIONS OF TOTAL PRODUCTIVE MAINTENANCE (TPM): Definition and distinctive features, developmental stages, zero defects and TPM, relationship between TPM, Terotechnology and Logistics; Overall Equipment Effectiveness: Six major losses, OEE metrics, process average method, weighted process average method, total equipment effectiveness equipment performance (TEEP), financial aspects of OEE, data acquisition for OEE. (10)

AUTONOMOUS MAINTENANCE (JISHU HOZEN): Specific goals for equipment, operators, technicians, detecting minor machine defects, setting standards, typical examples, machine tags, and one-point lessons –typical examples. Autonomous Maintenance: Seven levels - initial cleaning, preventive cleaning machines, cleaning and lubrication standard, general inspection, autonomous inspection, process disciple, independent autonomous maintenance. (12)

PREVENTIVE MAINTENANCE (PM): Elements of preventive maintenance, PM checklist, PM schedules, inspection specification, replacement part numbers, PM procedure, part logs, quality checks, PM Master-plan. (11)

TPM IMPLEMENTATION: Introduction of TPM to the organization, creation of organization structure, Basic TPM policies and aids, master plan, Kick start. TPM implementation stages: Small group activities, implementing AM, establishing planned maintenance, training and education, developing equipment management program, perfecting TPM implementation – raising TPM levels, case studies. (12)

Total L: 45

REFERENCES:

1. Andrew K.S.Jardineand Albert H.C.Tsang, "Maintenance, Replacement and Reliability", Taylor and Francis, 2006.
2. BikasBadhuryandS.K.Basu, "Tero Technology: Reliability Engineering and Maintenance Management", Asian Books, 2003.
3. Hansen R C, "Overall Equipment Effectiveness: A Powerful Production Maintenance Tool", Industrial Press, USA, 2001.
4. Robinson C J and Ginder A P, "Implementing TPM: The North American Experience", Productivity Press, USA, 1995.
5. Seichi Nakajima, "Total Productive Maintenance", Productivity Press, 1993.

21MN30 HUMAN RESOURCE MANAGEMENT
vide Lean Manufacturing 21ML26

21MN31 SUSTAINABILITY MANAGEMENT
vide Lean Manufacturing 21ML36

21MN32 ENTREPRENEURSHIP DEVELOPMENT
vide Lean Manufacturing 21ML22

21MN33 INDUSTRIAL INTERNET OF THINGS
vide Computer Integrated Manufacturing 21MC25

OPEN ELECTIVE THEORY COURSES (One to be opted)

21MN91 BUSINESS ANALYTICS IN PRACTICE
vide Computer Integrated Manufacturing 21MC91

21MN92 LIFE CYCLE ASSESSMENT AND ECO – DESIGN
vide Computer Integrated Manufacturing 21MC92

21MN93 SYSTEMS ENGINEERING AND MANAGEMENT
vide Computer Integrated Manufacturing 21MC93