B.E. – MECHANICAL ENGINEERING

ACADEMIC CURRICULUM & SYLLABUS

(REGULATIONS 2019 V.21)

CHOICE BASED CREDIT SYSTEM

(Applicable to the students admitted from the Academic Year 2019-20 onwards)

OPEN ELECTIVE- SYLLABUS

EASWARI ENGINEERING COLLEGE
(Autonomous Institution)
Bharathi Salai, Ramapuram, Chennai - 600 089

[A Unit of SRM Group of Educational Institutions, Approved by AICTE | Affiliated to Anna University, Chennai | NAAC Accredited 'A' Grade | 2(f) & 12(B) Status (UGC) | ISO 9001:2015 Certified | NBA Accredited Programmes | FIST Funded (DST) | SIRO Certified (DSIR)]

LIST OF OPEN ELECTIVE COURSES

S.NO	COURSE CODE	COURSE NAME
OPEN ELECTIVE -I		
1	191MEO501T	RENEWABLE ENERGY SOURCES
2	191MEO502T	INDUSTRIAL NANOTECHNOLOGY
3	191MEO503T	INDUSTRIAL SAFETY ENGINEERING
4	191MEO504T	PRODUCT DESIGN AND DEVELOPMENT
5	191MEO505T	BIOMECHANICS
OPEN ELECTIVE -II		
1	191MEO601T	VIBRATION AND NOISE CONTROL
2	191MEO602T	LEAN SIX SIGMA
3	191MEO603T	ENERGY CONSERVATION AND MANAGEMENT
4	191MEO604T	INDUSTRIAL TRIBOLOGY
5	191MEO605T	OPTIMIZATION TECHNIQUES FOR ENGINEERING SYSTEMS
OPEN ELECTIVE -III		
1	191MEO701T	ROBOTICS
2	191MEO702T	TESTING OF MATERIALS
3	191MEO703T	GREEN BUILDING DESIGN
4	191MEO704T	SUPPLY CHAIN MANAGEMENT
5	191MEO705T	TOTAL QUALITY MANAGEMENT AND RELIABILITY ENGINEERING
6	191MEO706T	OPERATIONS RESEARCH AND MANAGEMENT

191MEO501T	RENEWABLE ENERGY SOURCES	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To get exposure on solar radiation and its environmental impact to power.
2.	To know about the various collectors used for storing solar energy.
3.	To know about the various applications in solar energy.
4.	To learn about the wind energy and biomass and its economic aspects.
5.	To know about geothermal energy with other energy sources.

UNIT	TITLE	PERIODS
I	PRINCIPLES OF SOLAR RADIATION	9
Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data		
UNIT	TITLE	PERIODS
II	SOLAR ENERGY COLLECTION	9
Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.		
UNIT	TITLE	PERIODS
III	SOLAR ENERGY STORAGE AND APPLICATIONS	9
Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.		
UNIT	TITLE	PERIODS
IV	WIND ENERGY	9
Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. Engine operation and economic aspects.		
UNIT	TITLE	PERIODS
V	GEOTHERMAL ENERGY	9
Resources, types of wells, methods of harnessing the energy, potential in India. OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini - hydel power plants, and their economics. DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, principles of DEC.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Understanding the physics of solar radiation.
CO2:	Ability to classify the solar energy collectors and methodologies of storing solar energy.
CO3:	Knowledge in applying solar energy in a useful way.
CO4:	Knowledge in wind energy and biomass with its economic aspects.
CO5:	Knowledge in capturing and applying other forms of energy sources like wind, biogas and geothermal energies.

TEXT BOOKS:	
1.	Rai G.D. , “Non-Conventional Energy Sources”, Khanna Publishers, 2011
2.	Twidell & Wier, “Renewable Energy Resources”, CRC Press (Taylor & Francis), 2011

REFERENCE BOOKS:	
1.	Tiwari and Ghosal, “Renewable energy resources”, Narosa Publishing House, 2007
2.	Ramesh R & Kumar K.U , “Renewable Energy Technologies”,Narosa Publishing House, 2004
3.	Mittal K M , “Non-Conventional Energy Systems”, Wheeler Publishing Co. Ltd, New Delhi, 2003
4.	Kothari D.P, Singhal ., K.C., “Renewable energy sources and emerging technologies”, P.H.I, New Delhi, 2010

191MEO502T	INDUSTRIAL NANOTECHNOLOGY	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To elucidate on advantages of nanotechnology based applications in each industry
2.	To provide instances of contemporary industrial applications of nanotechnology
3.	To provide an overview of future technological advancements and increasing role of nanotechnology in each industry

UNIT	TITLE	PERIODS
I	NANO ELECTRONICS	9

Advantages of nano electrical and electronic devices –Electronic circuit chips – Lasers - Micro and Nano Electro mechanical systems – Sensors, Actuators, Optical switches,- Data memory –Lighting and Displays – Batteries - Fuel cells and Photo-voltaic cells – Electric double layer capacitors – Lead-free solder – Nanoparticle coatings for electrical products

UNIT	TITLE	PERIODS
II	BIONANOTECHNOLOGY	9

Nanoparticles in bone substitutes and dentistry – Implants and Prosthesis – Nanorobotics in Surgery –Nanosensors in Diagnosis– Neuro-electronic Interfaces– Therapeutic applications.

UNIT	TITLE	PERIODS
III	NANOTECHNOLOGY IN CHEMICAL INDUSTRY	9

Nanocatalyts – Smart materials – Heterogenous nanostructures and composites – Nanostructures for Molecular recognition (Quantum dots, Nanorods, Nanotubes) – Molecular Encapsulation and its applications – Nanoporous zeolites – Self-assembled Nanoreactors.

UNIT	TITLE	PERIODS
IV	NANOTECHNOLOGY IN AGRICULTURE AND FOOD TECHNOLOGY	9

Nanotechnology in Agriculture -Precision farming, Smart delivery system – Insecticides using nanotechnology – Potential of nano-fertilizers - Nanotechnology in Food industry

UNIT	TITLE	PERIODS
V	NANOTECHNOLOGY IN TEXTILES AND COSMETICS	9

Nanofibre production - Electrospinning – Controlling morphologies of nanofibers – Tissue engineering application– Polymer nanofibers - Nylon-6 nanocomposites from polymerization - Nano-filled polypropylene fibers - Nano finishing in textiles (UV resistant, antibacterial, hydrophilic, self-cleaning, flame retardant finishes) – Modern textiles Cosmetics – Formulation of Gels, Shampoos, Hair-conditioners

TOTAL PERIODS:	45

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Understand the applications of nano materials in Electronic applications
CO2:	Apply their knowledge to select nano materials in medical field
CO3:	Know the nano materials used in chemical industries
CO4:	Effectively utilize their skills to use nano materials in agriculture sctor
CO5:	Apply their skills to utilize nano technology in Textile and Cosmetics field

REFERENCE BOOKS:	
1.	Neelina H. Malsch (Ed.),Biomedical Nanotechnology, CRC Press (2005)
2.	Udo H. Brinker, Jean-Luc Mieusset (Eds.), Molecular Encapsulation: Organic Reactions in Constrained Systems,Wiley Publishers (2010).
3.	Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center, (2006).

191MEO503T	INDUSTRIAL SAFETY ENGINEERING	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To enable the students to understand the fundamentals and first law of thermodynamics
2.	To make the students to understand second law of thermodynamics and apply it to open and closed systems, and to analyze the availability and entropy of a system.
3.	To help the students to understand and apply the properties of pure substances to analyze steam power cycles.
4.	To enable the students to understand and apply the concepts of real and ideal gases, equations of state and thermodynamic relations.
5.	To enable the students to learn about the properties of gas mixtures for evaluating the properties of moist air

UNIT	TITLE	PERIODS
I	SAFETY IN METAL WORKING AND WOOD WORKING MACHINES	9

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards. Inspection of material handling equipments.

UNIT	TITLE	PERIODS
II	SAFETY IN WELDING AND GAS CUTTING	9

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.

UNIT	TITLE	PERIODS
III	SAFETY IN COLD FORMING AND HOT WORKING OF METALS	9

Hot and cold working processes-Forging processes-Open, impression and closed die forging-types of Forging machines-Typical forging operations-Swaging- Defects in forged parts-Rolling of metals-Types of rolling mills-Flat strip rolling-Shape rolling operations-Defects in rolled parts-principle of rod and wire drawing-Tube drawing-Principles of extrusion-Types of Extrusion-hot and cold extrusion-Equipments used.

UNIT	TITLE	PERIODS
IV	SAFETY IN FINISHING, INSPECTION AND TESTING	9

Heat treatment operations, Electro Plating, Paint Shops, Sand And Shot Blasting, Safety In Inspection And Testing, Dynamic Balancing, Hydro Testing, Valves, Boiler Drums And Headers, Pressure Vessels, Air Leak Test, Steam Testing, Safety In Radiography, Personal Monitoring Devices, Radiation Hazards, Engineering And Administrative Controls, Indian Boilers Regulation.

UNIT	TITLE	PERIODS
V	**INDUSTRIAL SAFETY**	9
Advances in Industrial Ergonomics and safety, Work and protective clothing, Theory and practice of Industrial safety, Industrial Noise and Vibration, Machine Guarding and Industrial machine safety, Manual material handling, Modeling for safety and health.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Implement safety rules, standards, and codes in operating mechanical engineering and carpentry machines.
CO2:	Utilize safety procedures for handling industrial gases and conducting welding operations.
CO3:	Apply the concepts of cold forming and hot working of metals in relevant processes.
CO4:	Execute finishing and post-manufacturing safety techniques as per established regulations.
CO5:	Integrate ergonomics, health, and welfare measures to enhance worker safety in engineering environments.

REFERENCE BOOKS:	
1.	Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly, Accident Prevention Manual – NSC, Chicago, 2009.
2.	Charles D. Reese, Occupational Health and Safety Management, CRC Press, 2003.
3.	John V. Grimaldi and Rollin H. Simonds Safety Management by All India Travelers Book seller, New Delhi, 1989.
4.	John Davies, Alastair Ross, Brendan Wallace, Safety Management: A Qualitative Systems Approach, CRC Press, 2003.
5.	Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

191MEO504T	PRODUCT DESIGN AND DEVELOPMENT	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To learn various concepts involved to achieve the desired product quality.
2.	To gain knowledge in design for manufacturing to reduce the cost of the product
3.	To provide knowledge in various processes of concept development to implement new product.
4.	To gain knowledge in basic concepts of product design, product features and its architecture.
5.	To learn about common features of the product according to the needs of customer

UNIT	TITLE	PERIODS
I	INTRODUCTION	9
Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.		
UNIT	TITLE	PERIODS
II	CONCEPT GENERATION AND SELECTION	9
Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits		
UNIT	TITLE	PERIODS
III	PRODUCT ARCHITECTURE	9
Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.		
UNIT	TITLE	PERIODS
IV	INDUSTRIAL DESIGN	9
Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process– investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.		
UNIT	TITLE	PERIODS
V	DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT	9
Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs– Minimize		

system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Integrate customer need, product design, and development
CO2:	Generate various product development concepts and select suitable concept
CO3:	Understand various product design levels and manufacturability
CO4:	Simulate product performance and manufacturing processes.
CO5:	Understand the basic concepts of design for manufacturing and assembly

TEXT BOOKS:	
1.	Kari T.Ulrich and Steven D.Eppinger, ”Product Design and Development”, McGraw-Hill International Edns. 1999

REFERENCE BOOKS:	
1.	Kemnneth Crow, “Concurrent Engg./Integrated Product Development”, DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2.	Stephen Rosenthal, “Effective Product Design and Development”, Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3.	Staurt Pugh, “Tool Design –Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, New york, NY.

191MEO505T	BIOMECHANICS	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	Be exposed to principles of mechanics.
2.	Learn the mechanics of physiological systems.
3.	Be familiar with the mathematical models used in the analysis of biomechanical systems

UNIT	TITLE	PERIODS
I	INTRODUCTION TO MECHANICS	9
Principles of Mechanics, Vector mechanics, Mechanics of motion - Newton's laws of motion, Kinetics, Kinematics of motion, Fluid mechanics – Euler equations and Navier Stoke's equations, Visco elasticity, Constitutive equations, Stress transformations, Strain energy function.		
UNIT	TITLE	PERIODS
II	BIOFLUID MECHANICS	9
Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, Couette flow and Hagen-Poiseuille equation, turbulent flow. Cardiovascular system - biological and mechanical valves development, artificial heart valves testing of valves, Structure, functions, material properties and modelling of Blood vessels.		
UNIT	TITLE	PERIODS
III	BIOSOLID MECHANICS	9
Hard Tissues: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models – anisotropy. Soft Tissues: Structure, functions, material properties and modelling of Soft Tissues: Cartilage, Tendon, Ligament, Muscle.		
UNIT	TITLE	PERIODS
IV	BIOMECHANICS OF JOINTS AND IMPLANTS	9
Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle. Design of orthopaedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation		
UNIT	TITLE	PERIODS
V	MODELING AND ERGONOMICS	9
Introduction to Finite Element Analysis, Analysis of bio mechanical systems using Finite element methods, Graphical design. Ergonomics- Gait analysis, Design of work station, Sports biomechanics, Injury mechanics.		

TOTAL PERIODS:	45

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Explain the mechanics of physiological systems.
CO2:	Identify relationships between structure and function in tissues and the implications/importance of these relationships
CO3:	Identify the appropriate visco elasticity model for the mechanical behavior of a given biological tissue.
CO4:	Analyze the biomechanical systems.
CO5:	Analyze the forces at a skeletal joint for various static and dynamic human activities.

REFERENCE BOOKS:	
1.	Duane Knudson, “Fundamentals of Biomechanics”, Second Edition Springer Science Business Media, 2007
2.	Jay D. Humphrey, Sherry De Lange, “An Introduction to Biomechanics: Solids and Fluids, Analysis and Design”, Springer Science Business Media, 2004.
3.	Marcelo Epstein, “The Elements of Continuum Biomechanics”, ISBN: 978-1-119-99923-2, 2012.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEO601T	**VIBRATION AND NOISE CONTROL**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Nil

COURSE OBJECTIVES:

1.	To familiarize with fundamentals of vibration noise
2.	To understand different noise propagation
3.	To gain knowledge on noise measurement and its instrumentation techniques
4.	To apply various noise control techniques
5.	To understand various vibration control strategies

UNIT	TITLE	PERIODS
1	**INTRODUCTION TO VIBRATION NOISE**	**9**

Definition, basic attributes of sound (wavelength, period, frequency velocity, speed, pressure, power and sound intensity), units (decibel, dB (A) and SPL), Wave analysis of structures and spaces.

UNIT	TITLE	PERIODS
2	**ENVIRONMENTAL NOISE PROPAGATION**	**9**

Sources, distance from source, atmospheric absorption, wind, temperature, wind and temperature gradient, obstacles such as barriers and buildings, ground absorption, reflections, humidity.

UNIT	TITLE	PERIODS
3	**NOISE MEASUREMENT AND INSTRUMENTAION**	**9**

Noise measurement and control instrumentation, Leq and various noise metrics for aircraft and industrial noises. Noise Level indicators, Noise severity criteria, Various types of acoustic testing chambers.

UNIT	TITLE	PERIODS
4	**NOISE CONTROL**	**9**

Importance of reverberations time. Design of absorption systems for required reverberation time. Noise isolation design. Noise absorber design. Acoustic Design of Buildings Common strategies for reducing environmental noise exposure.

UNIT	TITLE	PERIODS
5	**VIBRATION CONTROL STRATEGIES**	**9**

Review of Vibration control measures, design of a Vibration Absorbers, unconstrained and constrained layer damping treatment, add on dampers, and stiffeners. Design of Isolators in machine foundations, Role of materials damping. Introduction to Active Vibration Control.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1:	Analyze different attributes of vibration and wave analysis of structure.
CO2:	Analyze the noise propagation mechanism in buildings.
CO3:	Apply acoustic testing methods to measure industrial vibration and noise
CO4:	Design noise absorption systems for reducing environmental noise exposure
CO5:	Develop test strategies of noise propagation

TEXT BOOKS:	
1.	Grover. G.T., “Mechanical Vibrations”, Nem Chand and Bros., 2009
2.	Singiresu S.Rao, “Mechanical Vibrations”, 6th Edition, Pearson Education, 2016.

REFERENCE BOOKS:	
1.	Balakumar Balachandran and Edward B. Magrab, “Fundamentals of Vibrations”,1st Editon, Cengage Learning, 2009
2.	Bernard Challen and Rodica Baranescu - “Diesel Engine Reference Book”, Second Edition, SAE International, 1999
3.	Colin Hansen , Scott Snyder , Laura Brooks, Active Control of Noise and Vibration, Second Edition, Volume 1, CRC Press, 2012
4.	Kewal Pujara, Vibration and Noise for Engineers, Dhanpat Rai & co, 2018

191MEO602T	LEAN SIX SIGMA	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	Explain the basics of Lean and Six Sigma.
2.	Teach the need and the process of integrating Lean and Six sigma.
3.	Summarize to identify and select the resources required for LSS Projects and selection of projects including Team building.
4.	Teach the DMAIC process and study the various tools for undertaking LSS projects.
5.	Illustrate to institutionalize the LSS efforts.

UNIT	TITLE	PERIODS
I	INTRODUCTION TO LEAN AND SIX SIGMA	9

Introduction to Lean- Definition, Purpose, Features of Lean ; Top seven wastes, Need for Lean management, The philosophy of lean management, Creating a lean enterprise, Elements of Lean, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six sigma, origin of six sigma, Six sigma concept and Critical success factors for six sigma.

UNIT	TITLE	PERIODS
II	INTEGRATION OF LEAN AND SIX SIGMA	9

Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, the principles of lean six sigma, Scope for lean six sigma, Features of lean six sigma. The laws of lean six sigma, Key elements of LSS, the LSS model and the benefits of lean six sigma. Initiation - Top management commitment — Infrastructure and deployment planning, Process focus, organizational structures, Measures — Rewards and recognition, Infrastructure tools, structure of transforming event and Launch preparation.

UNIT	TITLE	PERIODS
III	PROJECT SELECTION AND TEAM BUILDING	9

Resource and project selection, Selection of Black belts, Training of Black belts and Champions, Identification of potential projects, top down (Balanced score card) and Bottom-up approach — Methods of selecting projects — Benefit/Effort graph, Process mapping, value stream mapping, Predicting and improving team performance, Nine
team roles and Team leadership.

UNIT	TITLE	PERIODS
IV	THE DMAIC PROCESS AND TOOLS	9

The DMAIC process – Toll gate reviews; The DMAIC tools; Define tools – Project definition form, SIPOC diagram; Measure tools — Process mapping, Lead time/cycle time, Cause and Effect matrix, Idea — generating and organizing tools – Brainstorming, Nominal group technique and Multi-voting; Data collection and accuracy tools- Check sheet, Gauge R&R; Understanding and eliminating variation- run charts; Analyze tools - Scatter plots, ANOVA, Regression analysis, Time trap analysis; Improve tools – Mistake proofing, Set up time reduction (SMED)

and the pull system; Control tools – statistical process control.		
UNIT	**TITLE**	**PERIODS**
V	**INSTITUTIONALIZING AND DESIGN FOR LSS**	**9**
Institutionalizing lean six sigma — improving design velocity, creating cycle time base line, valuing projects, gating the projects, reducing product line complexity, Design for lean six sigma, QFD, Theory of Inventive Problem solving (TRIZ), Robust design; Case study presentations.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Understand what is Lean and Six sigma and their importance in the globalized competitive world.
CO2:	Understand the importance of integrating Lean and Six sigma and also the process of their integration.
CO3:	Plan the Resources required to undertake the LSS projects and also acquire how to select the suitable projects and the teams.
CO4:	Apply DMAIC methodology to execute LSS projects and in this regard they will be acquainted with various LSS tools.
CO5:	Understand the process of institutionalizing the LSS effort and also understandthe Design for LSS.

TEXT BOOKS:	
1.	Michael L. George, Lean Six Sigma, McGraw-Hill., 2002.

REFERENCE BOOKS:	
1.	James P. Womack, Daniel T. Jones, Lean Thinking, Free press business., 2003.
2.	Ronald G.Askin and Jeffrey B.Goldberg, Design and Analysis of Lean Production Systems, John Wiley &Sons., 2003.
3.	Salman Taghizadegan, Essentials of Lean Six Sigma, Elsevier., 2010.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEO603T	**ENERGY CONSERVATION AND MANAGEMENT**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Nil

COURSE OBJECTIVES:	
1	Understand and analyze the energy data of industries
2	Carryout energy accounting and balancing
3	Conduct energy audit and suggest methodologies for energy savings and
4	Utilize the available resources in optimal ways
5.	To learn Energy Conservation practices using Economics principles and Strategies.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**8**
Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.		
UNIT	**TITLE**	**PERIODS**
2	**ELECTRICAL SYSTEMS**	**12**
Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.		
UNIT	**TITLE**	**PERIODS**
3	**THERMAL SYSTEMS**	**12**
Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Energy Efficiency of turbines, compressors and pumps, specific energy consumption, parameters affecting specific energy consumption, flexi targeting technique. Cogeneration: types and schemes, case study , Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories, The Energy efficiency home.		
UNIT	**TITLE**	**PERIODS**
4	**ENERGY CONSERVATION IN MAJOR UTILITIES**	**8**
Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets. Energy Audits and Improvements for Commercial Buildings		
UNIT	**TITLE**	**PERIODS**
5	**ECONOMICS**	**5**
Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept, Energy conservation in vehicles, energy conservation in buildings, Power quality issues related to Energy Efficient Technologies, Energy Conservation Practice – Case Studies		
Case studies: Energy saving measures/ projects, Heat Ventilating and Air-Conditioning (HVAC) -Energy Conservation Practice		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Demonstrate the energy auditing methods, barriers with the help of energy auditing instruments
CO2:	Evaluate the energy efficiencies of electrical systems through energy audit
CO3:	Evaluate the energy efficiencies of thermal systems through energy audit
CO4:	Infer the areas where energy conservation is possible for improvements in commercial buildings
CO5:	Evaluate the energy economic strategies of vehicles and buildings
CO6:	Estimate the energy utilization and conservation in buildings and vehicles

TEXT BOOKS:	
1.	Ian M. Shapiro, “Energy Audits and Improvements for Commercial Buildings”Wiley,2011
2.	K. V. Sharma., P. Venkataseshaiah, “Energy Management and Conservation”I K International Publishing, 2011.
3.	S. S. Thipse. “Energy Conservation and Management”,Alpha Science International, 2014.

REFERENCE BOOKS:	
1.	Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.
2.	Patrick Waterfield.” The ENERGY EFFICIENT HOME: A Complete Guide “2011.
3.	Witte. L.C., P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEO604T	**INDUSTRIAL TRIBOLOGY**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Nil

COURSE OBJECTIVES:

1.	To familiarize the knowledge on surface engineering and surface modification methods that will come in handy to solve the industrial problems.
2.	To impart knowledge in the friction and wear aspects of machine components.
3.	To gain knowledge in the lubrication aspects of machine components.
4.	To provide the knowledge on to apply and solve the industrial problems that arise related to Corrosion of surfaces.
5.	To understand the material properties which influence the tribological characteristics of surfaces.

UNIT	TITLE	PERIODS
1	**SURFACE INTERACTION AND FRICTION**	**8**

Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non-metallic materials.

UNIT	TITLE	PERIODS
2	**WEAR CHARACTERISTICS**	**9**

Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear-Laws of wear – Theoretical wear models – Wear of metals and non metals – International standards in friction and wear measurements.

UNIT	TITLE	PERIODS
3	**LUBRICANTS AND LUBRICATION REGIMES**	**8**

Lubricants and their physical properties – Viscosity and other properties of oils – Additives and selection of Lubricants – Lubricant standards ISO, SAE, AGMA, BIS standards – Lubrication Regimes – Solid Lubrication – Hydrodynamic lubrication – Hydrostatic lubrication – Gas lubrication.

UNIT	TITLE	PERIODS
4	**CORROSION**	**10**

Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Cathodic and Anodic Protection.

UNIT	TITLE	PERIODS
5	**SURFACE TREATMENTS**	**10**

Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control –New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Corrosion resistant coatings.

Case studies: Case study of wear and corrosion resistant coatings on industrial applications, Case study of Nano coatings on industrial applications,

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Examine the surface features and frictional properties of Metallic and Non Metallic Materials
CO2:	Appreciate the various modes of wear and the wear-mechanisms.
CO3:	Select suitable lubricants and lubrication regimes for different operating conditions in industrial applications.
CO4:	Test the corrosion properties of metals
CO5:	Apply surface coatings on materials to control wear and corrosion

TEXT BOOKS:	
1.	Basu.S.K, Sengupta.S.N and Ahuja.B.B, ”Fundamentals of Tribology” Prentice – Hall of India Pvt Ltd , New Delhi, 2005.
2.	Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981.
3.	Fontana G., “Corrosion Engineering”, McGraw Hill, 1985.
4.	Halling, J, “Principles of Tribology”, Macmillian – 1984.
5.	Rabinowicz. E, “Friction and Wear of materials”, John Willey &Sons ,UK,1995.
6.	Stachowiak.G.W and Batchelor.A.W, “Engineering Tribology”, Butterworth - Heinemann, UK, 2005.
7.	Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.

REFERENCE BOOKS:	
1.	Avraham Harnoy, “Bearing Design in Machinery: Engineering Tribology and Lubrication”, Dekker 2007.
2.	Giovanni Straffelini, “Friction and Wear: Methodologies for Design and Control”, Springer 2015
3.	Michael Khonsari.M, “Applied Tribology: Bearing Design and Lubrication”, Wiley Blackwell; 2nd Revised edition, 2008.
4.	Stolarsk.T.A, “Tribology in Machine Design, Butterworth”, – Heinemann, UK, 2013.

191MEO605T	OPTIMIZATION TECHNIQUES FOR ENGINEERING SYSTEMS	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To make use of the various optimization techniques while modeling and solving the engineering problems of different fields.

UNIT	TITLE	PERIODS
I	INTRODUCTION	9
Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimizationproblem — classification of optimization problems.		
UNIT	TITLE	PERIODS
II	CLASSIC OPTIMIZATION TECHNIQUES	9
Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method –duality in LP – Parametric Linear programming – Goal Programming		
UNIT	TITLE	PERIODS
III	NON-LINEAR PROGRAMMING	9
Introduction – Lagrangian Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming		
UNIT	TITLE	PERIODS
IV	INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES	9
Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration — Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem		
UNIT	TITLE	PERIODS
V	ADVANCES IN SIMULATION	9
Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems		

TOTAL PERIODS:	45

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	understand the framework and scope of Optimization techniques.
CO2:	solve various optimization techniques.
CO3:	understand the Importance non programming and its applications.
CO4:	understand and apply network techniques.
CO5:	Apply and analyze simulation-based techniques.

TEXT BOOKS:	
1.	Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 1997

REFERENCE BOOKS:	
1.	J.K.Sharma, Operations Research – Theory and Applications – Macmillan India Ltd., 1997
2.	R. Panneerselvam, —Operations Researchll, Prentice Hall of India Private Limited, New Delhi 1 – 2005
3.	P.K. Guptha and Man-Mohan, Problems in Operations Research – Sultan chand & Sons, 1994

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEO701T	**ROBOTICS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To gain knowledge in the basic principles and information on robotics, robot configurations and robot motions.
2.	To learn major robot control components and operations required to automate a process or an activity
3.	To familiar with appropriate sensor and machine vision system for a given application.
4.	To learn the programming techniques for various robotic applications.
5.	To understand the robots in various industrial sectors and summarize the need and application of robots in different sectors.

UNIT	**TITLE**	**PERIODS**
1	**FUNDAMENTALS OF ROBOT**	**9**
Robot - Definition - Robot Anatomy – Coordinate Systems, Work Envelope Types and Classification-Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.		
UNIT	**TITLE**	**PERIODS**
2	**ROBOT DRIVE SYSTEMS AND END EFFECTORS**	**9**
Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.		
UNIT	**TITLE**	**PERIODS**
3	**SENSORS AND MACHINE VISION**	**9**
Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications- Inspection, Identification, Visual Serving and Navigation.		
UNIT	**TITLE**	**PERIODS**
4	**ROBOT KINEMATICS AND ROBOT PROGRAMMING**	**9**
Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.		
UNIT	**TITLE**	**PERIODS**
5	**IMPLEMENTATION AND ROBOT ECONOMICS**	**9**

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, Students will be able to:	
CO1:	Articulate the basic concepts of Robots, Robot drives and controls.
CO2:	Apply inverse kinematics and robot dynamics for basic control system and its components.
CO3:	Interpret images acquired through various sensors using machine vision techniques.
CO4:	Create programs for Robots using the AI concepts of Knowledge representation and Search techniques
CO5:	Apply Robots for various industrial applications.

TEXT BOOKS:	
1.	Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2001.
2.	Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2003.

REFERENCE BOOKS:	
1.	Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008.
2.	Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 1994.
3.	Koren Y., “Robotics for Engineers", Mc Graw Hill Book Co., 1992.
4.	Fu.K.S.,Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.
5.	Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 1995.
6.	Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2008.

191MEO702T	TESTING OF MATERIALS	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To understand process of material testing
2.	To understand the various mechanical testes
3.	To study the various nondestructive testing methods
4.	To understand the operation of SEM and TEM
5.	To learn the advanced material characterization techniques

UNIT	TITLE	PERIODS
I	INTRODUCTION TO MATERIALS TESTING	9

Overview of materials, Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing.

UNIT	TITLE	PERIODS
II	MECHANICAL TESTING	9

Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, Applications

UNIT	TITLE	PERIODS
III	NON-DESTRUCTIVE TESTING	9

Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT	TITLE	PERIODS
IV	MATERIAL CHARACTERIZATION TESTING	9

Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.

UNIT	TITLE	PERIODS
V	OTHER TESTING	9
Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermo- mechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.		

TOTAL PERIODS:	45

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Identify suitable testing standards for conducing destructive and nondestructive testing
CO2:	Identify suitable destructive testing for identifying the properties of materials
CO3:	Identify suitable Non-destructive testing for identifying defects in a material as per industrial standards.
CO4:	Identify suitable characterization technique for identifying internal defects in a material
CO5:	Ability to use the different technique and know its applications and limitations

TEXT BOOKS:	
1.	Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2.	Cullity, B. D., “Elements of X-ray diffraction”, 3rd Edition, Addison-Wesley Company Inc., New York, 2000.
3.	P. Field Foster, “The Mechanical Testing of Metals and Alloys” 7th Edition, Cousens Press, 2007.

REFERENCE BOOKS:	
1.	ASM Metals Handbook, “Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA.
2.	Brandon D.G., “Modern Techniques in Metallography”, Von Nostrand Inc. NJ, USA, 1986.
3.	Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.

191MEO703T	GREEN BUILDING DESIGN	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	Learn principles of Heat transfer mechanisms in Buildings.
2.	Applications of Building materials and energy management techniques.
3.	Be familiar with the Alternative concepts and Green Composites for Building systems

UNIT	TITLE	PERIODS
I	ENVIRONMENTAL IMPLICATIONS OF BUILDINGS	9
Energy use, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. Embodied Energy in Building Materials: Transportation Energy for Building Materials; Maintenance Energy for Buildings		
UNIT	TITLE	PERIODS
II	IMPLICATIONS OF BUILDING TECHNOLOGIES EMBODIED ENERGY OF BUILDINGS	9
Framed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts. Recycling of Industrial and Buildings Wastes. Biomass Resources for buildings.		
UNIT	TITLE	PERIODS
III	COMFORTS IN BUILDING	9
Thermal Comfort in Buildings- Issues; Heat Transfer Characteristic of Building Materials and Building Techniques. Incidence of Solar Heat on Buildings-Implications of Geographical Locations		
UNIT	TITLE	PERIODS
IV	UTILITY OF SOLAR ENERGY IN BUILDINGS	9
Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings.		
UNIT	TITLE	PERIODS
V	GREEN COMPOSITES FOR BUILDINGS	9
Concepts of Green Composites. Water Utilization in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.		

	TOTAL PERIODS: 45

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Select the appropriate building materials for energy applications
CO2:	Imply various energy building technologies
CO3:	Design thermal confort system in building
CO4:	Implement solar techniques for Passive heating and cooling applications
CO5:	Comprehend the water and solar waste management in Buildings

TEXT BOOKS:	
1.	K.S.Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials and Technologies. New Age International, 2007.
2.	Low Energy Cooling For Sustainable Buildings. John Wiley and Sons Ltd, 2009.
3.	Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004.

REFERENCE BOOKS:	
1.	Fundamentals of Integrated Design for Sustainable Building By Marian Keeler, Bill Burke
2.	Jerry Yudelson Green building Through Integrated Design. McGraw Hill, 2009.
3.	Osman Attmann Green Architecture Advanced Technologies and Materials. McGraw Hill, 2010.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEO704T	**SUPPLY CHAIN MANAGEMENT AND LOGISTICS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To provide an insight on the fundamentals of supply chain networks, tools and techniques
2.	To address the sourcing and analysis and strategic building concepts and methods behind Supply chain management and Logistics.
3.	To understand the role of Logistics in Supply chain management.
4.	To educate the importance of Information technology in Supply chain management.
5.	To understand the concept of network design in supply chain.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**9**
Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles-Implementation.		
UNIT	**TITLE**	**PERIODS**
2	**SUPPLY CHAIN NETWORK DESIGN**	**9**
Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions		
UNIT	**TITLE**	**PERIODS**
3	**LOGISTICS IN SUPPLY CHAIN**	**9**
Role of transportation in supply chain – factors affecting transportations decision – Routing and scheduling in transportation- Risk Pooling and postponement strategy, inventory management.		
UNIT	**TITLE**	**PERIODS**
4	**SOURCING AND COORDINATION IN SUPPLY CHAIN**	**9**
Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain. Beer game strategy – Case Study		
UNIT	**TITLE**	**PERIODS**
5	**SUPPLY CHAIN AND INFORMATION TECHNOLOGY**	**9**
The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain –E-Business in supply chain.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, Students will be able to:	
CO1:	Apply various decisions phases and strategies for improving supply chain performance of an organization.
CO2:	Construct suitable network design for increasing Supply chain performance.
CO3:	Develop suitable logistics network design for Transportation in Supply chain.
CO4:	Choose appropriate sourcing and coordination contracts with supplier for building strategic partnerships and trust within a supply chain.
CO5:	Integrate IT tools in current trends with Internal and supplier relationship management.

TEXT BOOKS:	
1.	Janat Shah ,Supply Chain Management 2/e: Text and Cases ,Pearson Education,2016.
2.	Sunil Chopra, Peter Meindl and Kalra, “Supply Chain Management, Strategy, Planning, and operation”, Pearson Education, 2010.

REFERENCE BOOKS:	
1.	David J.Bloomberg , Stephen Lemay and Joe B.Hanna, “Logistics”, PHI 2002.
2.	David Simchi-Levi and Philip Kaminsky and Edith Simchi-Levi,Designing And Managing the Supply Chain: Concepts, Strategies and Case studies | 3rd Edition,2008.
3.	James B.Ayers, “Handbook of Supply chain management”, St.Lucle press, 2000.
4.	Jeremy F.Shapiro, “Modeling the supply chain”, Thomson Duxbury, 2002.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEO705T	**TOTAL QUALITY MANAGEMENT AND RELIABILITY ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	Understand the importance of TQM and its concepts, tools and techniques.
2.	Understand the role of human involvement to improve the quality of product and service.

UNIT	TITLE	PERIODS
1	**BASIC CONCEPTS**	**9**

Definition of quality and Total Quality Management and evolution of TQM, Comparison between traditional approach and TQM, Deming, and Cros by principles of TQM, Juran, and Taguchi concept of TQM, Ishikawa concept of TQM; cost of quality, Concept of Product quality and Service quality, Bench marking and Strategic planning for quality. Goal setting for quality; the Steps involved in strategic planning. TQM implementation, its benefits and its setbacks.

UNIT	TITLE	PERIODS
2	**TQM PRINCIPLES & BASIC TOOLS**	**9**

Customer supplier chain, Customer perception of quality. Customer feedback, Customer complaints, Customer retention. Employee involvement, Employee motivation: Maslow's hierarchy of needs. Herzberg theory of motivation, Empowerment, and teamwork. Introduction to seven basic tools: Check sheet, histogram, Control chart. Pareto diagram, Cause and effect diagram, Stratification, and Scatter diagram. Introduction to 5S, Introduction to Kaizen. Introduction to Six-Sigma.

UNIT	TITLE	PERIODS
3	**NEW SEVEN MANAGEMENT TOOLS & ADVANCED QUALITY TOOLS**	**9**

Affinity diagram, Relations diagram, Tree diagram, Matrix diagram. Matrix data analysis diagram, Process decision program chart, Arrow diagram, Quality Function Deployment (QFD)Root cause analysis and its uses. Taguchi method and quality loss function. Mistake proofing (POKA– YOKE); Failure mode and effects analysis (FMEA), Failure mode and effects and Criticality analysis (FMECA). Fault Tree Analysis (FTA)

UNIT	TITLE	PERIODS
4	**RELIABILITY**	**9**

Introduction and definition about reliability, Probabilistic nature of failures. Mean failure rate and Mean time between failures (MTBF) of component/ system, Hazard rate and Hazard models, Weibull model for reliability of components/systems, Reliability of components in Series configuration, Reliability of components in Parallel configuration, Redundant and Mixed configurations. System reliability improvement, Case studies in reliability of system.

UNIT	TITLE	PERIODS
5	**MAINTAINABILITY**	**9**

Introduction and definition of maintainability, availability, Choice of maintenance strategy. Mean time to repair (MTTR), Factors contributing to Mean Down Time (MDT), Fault diagnosis, and routine testing forum revealed faults. Factors contributing to Mean Maintenance Time (MMT), Types of maintenance, Economics of maintenance.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, Students will be able to	
CO1:	Apply Basic concepts of TQM
CO2:	Analyze the various methods under transportation model and apply the model for testing the closeness of their results to optimal results
CO3:	Apply the concepts of PERT and CPM for decision making and optimally managing projects
CO4:	Analyze the various Reliability Decisions
CO5:	Analyze and apply appropriate Maintainability

TEXT BOOKS:	
1.	JoelE.Ross, SusanPerry, Tota lQuality Management: Text, Cases, and Readings", ,CRC Press, 3rdEdition, 1999.
2.	Srinath,L.S., "ReliabilityEngineering",,EastWestPress,NewDelhi,4thEdition 1995.

REFERENCE BOOKS:	
1.	Balagurusamy,E., "ReliabilityEngineering",TataMcGrawHillpublishingCo.,NewDelhi,1984.
2.	GregBound,et.al,Beyond, "TotalQualityManagementtowardstheemergingparadigm",McGrawHillInc.,1994.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEO706T	**OPERATIONS RESEARCH AND MANAGEMENT**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To understand the various model formations and their industrial applications.
2.	To understand the various models of transportation and assignment problems.
3.	To evaluate the critical path and duration of project & process.
4.	To understand about replacement methods with sequencing.
5.	To understand the concept of Inventory control and queuing theory.

UNIT	**TITLE**	**PERIODS**
1	**LINEAR MODEL**	**9**
The phases of OR study – Formation of an L.P model – Graphical solution – Simplex algorithm – Artificial variables technique (Big M method, two phase method), Duality in simplex.		
UNIT	**TITLE**	**PERIODS**
2	**TRANSPORTATION AND ASSIGNMENT PROBLEM**	**9**
Transportation model – Initial solution by North West corner method – Least Cost method – VAM. Optimality test – MODI method and stepping stone method. Assignment model – Formulation – Balanced and unbalanced assignment problems.		
UNIT	**TITLE**	**PERIODS**
3	**PROJECT MANAGEMENT BY PERT & CPM**	**9**
Basic terminologies – Constructing a project network – Scheduling computations – PERT - CPM – Resource smoothening, Resource leveling, PERT Cost.		
UNIT	**TITLE**	**PERIODS**
4	**REPLACEMENT AND SEQUENCING MODELS**	**9**
Replacement policies - Replacement of items that deteriorate with time (value of money not changing with time) – Replacement of items that deteriorate with time (Value of money changing with time) – Replacement of items that fail suddenly (individual and group replacement policies). Sequencing models- n job on 2 machines – n jobs on 3 machines – n jobs on m machines, Traveling salesman problem.		
UNIT	**TITLE**	**PERIODS**
5	**INVENTORY AND QUEUING THEORY**	**9**
Variables in inventory problems, EOQ, deterministic inventory models, order quantity with price break, techniques in inventory management. Selective inventory control, Safety stock calculations, Queuing system and its structure – Kendall's notation – Common queuing models - M/M/1: FCFS/8/8 - M/M/1: FCFS/n/8 - M/M/C: FCFS/8/8.		
	TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, Students will be able to	
CO1:	Apply linear programming model for optimizing various industrial process.
CO2:	Analyze the various methods under transportation model for evolving the optimal results.
CO3:	Apply the concepts of PERT and CPM for decision making in managing projects.

CO4:	Analyze the various replacement and sequencing models for arriving at optimal decision.
CO5:	Apply appropriate inventory and queuing theories in domain specific situations.

TEXT BOOKS:	
1.	Hira and Gupta “Problems in Operations Research”, S.Chand and Co.2008
2.	Taha H.A, “Operation Research”, Pearson Education sixth edition, 2003

REFERENCE BOOKS:	
1.	Budnick F.S., “Principles of Operations Research for Management”, Richard D Irwin, 1990.
2.	Shennoy G.V. and Srivastava U.K., “Operation Research for Management”, Wiley Eastern, 1994.
3.	Tulsian and Pasdey V., “Quantitative Techniques”, Pearson Asia, 2002.