SRI SATYA SAI UNIVERSITY OF TECHNOLOGY AND MEDICAL SCIENCES
SCHOOL OF ENGINEERING
Outcome based Curriculum for
Undergraduate Degree Courses in Engineering & Technology

Department of Mechanical Engineering

BE-SEMESTER-VI SYLLABUS

MEA-601	**NC and CNC Machine tools**	**2L:1T:0P**	**03 credits**	**3Hrs/Week**

Course Preamble:

This course covers Fundamentals and concepts of CNC machining centers, NC part programming, Programming through CAD/CAM (Master CAM), and Maintenance and Troubleshooting the CNC machine tools. This course offers more hands on experience through which the participants will be developing CNC programs and machining complicated shapes by using the CNC machine tools.

Course Outcomes:

The participants will be able to:

1. Understand fundamentals of NC/CNC
2. Learn and Write NC Part Programming
3. Learn NC Programming through CAD/CAM
4. Hands –on experience on Master CAM
5. Learn Tooling for NC/CNC
6. Understand machines like Chucking and Turning Centres, Machining Centres
7. Learn Maintenance and Trouble Shooting of CNC Machine Tools

UNIT - I:

Introduction: Fundamentals of numerical control, advantages limitations of N.C systems - classification of N.C systems. **Computer Numerical Control:** Nomenclature, types and features of CNC machine tools, machine control unit, position control and its significance, engineering analysis of NC positioning systems, open loop and closed loop systems, precision in NC positioning systems-control resolution, accuracy and repeatability. Actuators: servomotors, stepper motors, transducers and feedback elements.

(9 hours)

UNIT - II

Features of N.C. Machine tools: Design consideration of N.C machine tools - increasing productivity with N.C machines, tooling for CNC machine. **System Device:** Feed back system-counting devices digital analog converters. **Interpolations:** DDA integrators, simple and symmetrical DD reference word CNC interpolators. **(8 hours)**

UNIT - III

Part Programming: Process planning and flow chart for part programming, systems nomenclature and tool geometries, Tool presetting & modular tooling. Selection of tools based on machining capacity, accuracy and surface finish, elements of programming for turning and milling, part programming. Preparatory codes G, miscellaneous functions M, Interpolation, tool compensations, cycles for simplifying programming, typical part programming **Control Loops for N C Systems:** Introduction-control loops for point and counting systems.

(10 hours)

UNIT - IV

Computerized Numerical Control: CNC concepts-advantage of CNC reference planes, sampled data techniques, microcomputers in CNC. **Adaptive Control Systems:** Adaptive control with optimization and constraints-variable gains AC systems.

(8 hours)

UNIT - V

Modern CNC machines: CNC lathes, turning centers, machining centres, automatic pallet changers, automatic tool changers, direct numerical control and applications, CNC machine design features.

(8 hours)

REFERENCE :

1. Numerical control of machine tool – Koren & Ben Uri – Khanna Publisher,Delhi
2. Automation, Production Systems and Computer Integrated Manufacturing - Groover – PHI.
3. CNC Programming - S.K. Sinha - Galgotia
4. Mechatronics - HMT –TMH,Delhi
5. Numerical Control and Computer Aided Manufacturing -Tewari, Rao, Kundra- TMH, Delhi
6. Machine Tool Design and Numerical Control – N.K.Mehta – TMH Delhi
7. Fundamentals of Computer Numerical Control – NIIT – Prentice Hall, Delhi

MEA-601	**NC and CNC Machine tools**	**0L:0T:2P**	**1 credits**	**2Hrs/Week**

List of Experiment:

1. To make a Program on cnc lathe machine with all operations like turning, step turning, drilling, tapper turning, thread cutting and knurling .
2. To make a job on cnc lathe machine with all operations like turning, step turning, drilling, tapper turning, thread cutting and knurling.
3. To Study of different control systems and NC codes.
4. To Study of different control systems and CNC codes.
5. To make a Program for circular interpolation,
6. To make a program on cnc milling machine gear teeth
7. To make a job on cnc milling machine gear teeth

MEA – 602	Heat and Mass Transfer	2L:1T:0P	03 credits	3Hrs/Week

Course Preamble:
The main learning objective of this course is to prepare the students for:

1. Applying the principle mechanism of heat transfer under steady state and transient conditions.
2. Applying the fundamental concept and principles in convective heat transfer.
3. Applying the theory of phase change heat transfer and design of heat exchangers.
4. Applying the fundamental concept and principles in radiation heat transfer.
5. Analyzing the relation between heat and mass transfer and to solve simple mass transfer problems.

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Apply the principle mechanism of heat transfer under steady state and transient conditions.
2. Apply the fundamental concept and principles in convective heat transfer.
3. Apply the theory of phase change heat transfer and design of heat exchangers.
4. Apply the fundamental concept and principles in radiation heat transfer.
5. Analyze the relation between heat and mass transfer and to solve simple mass transfer problems.

Unit-1

Basic Concepts: Modes of heat transfer, Fourier‟s law, Newton‟s law, Stefan Boltzman law; thermal resistance and conductance, analogy between flow of heat and electricity,combined heat transfer process; **Conduction:** Fourier heat conduction equation, its form in rectangular, cylindrical and spherical coordinates, thermal diffusivity, linear one dimensional steady state conduction through a slab, tubes, spherical shells and composite structures, electrical analogies, critical-insulation-thickness for pipes, effect of variable thermal conductivity.

(10 hours)

Unit 2

Extended surfaces (fins): Heat transfer from a straight and annular fin (plate) for a uniform cross section; error in measurement of temperature in a thermometer well, fin efficiency, fin effectiveness,

applications; **Unsteady heat conduction:** Transient and periodic conduction, heating and cooling of bodies with known temperatures distribution, systems with infinite thermal conductivity, response of thermocouples.

(10 hours)

Unit 3

Convection: Introduction, free and forced convection; principle of dimensional analysis ,Buckingham „pie" theorem, application of dimensional analysis of free and forced convection ,empirical correlations for laminar and turbulent flow over flat plate and tubular geometry; calculation of convective heat transfer coefficient using data book.

(8 hours)

Unit 4

Heat exchangers: Types- parallel flow, counter flow; evaporator and condensers, overall heat transfers coefficient, fouling factors, log-mean temperature difference (LMTD), method of heat exchanger analysis, effectiveness of heat exchanger, NTU method;
Mass transfer: Fick"s law, equi-molar diffusion, diffusion coefficient, analogy with heat transfer, diffusion of vapor in a stationary medium.

(8 hours)

Unit 5

Thermal radiation: Nature of radiation, emissive power, absorption, transmission, reflection and emission of radiation, Planck"s distribution law, radiation from real surfaces; radiation heat exchange between black and gray surfaces, shape factor, analogical electrical network, radiation shields. **Boiling and condensation:** Film wise and drop wise condensation; Nusselt theory for film wise condensation on a vertical plate and its modification for horizontal tubes; boiling heat transfer phenomenon, regimes of boiling, boiling correlations.

(10 hours)

References:

1. Sukhatme SP; Heat and mass transfer; University Press Hyderabad
2. Holman JP; Heat transfer; TMH
3. Nag PK; heat and Mass Transfer; TMH
4. Dutta BK; Heat Transfer Principles And App; PHI Learning
5. Mills AF and Ganesan V; Heat transfer; Pearson
6. Cengel Yunus A; Heat and Mass transfer;TMH
7. Yadav R; Heat and Mass Transfer; Central India pub-Allahabad
8. Baehr HD;Stephan K; Heat and Mass Transfer; MacMillan

MEA– 602	**Heat and Mass Transfer**	**0L:0T:2P**	**1 credits**	**2Hrs/Week**

List of Experiments:

1. To determine Conduction through a rod to determine thermal conductivity of material
2. To understand the Forced and free convection over circular cylinder
3. To determine Free convection from extended surfaces
4. To determine Parallel flow and counter flow heat exchanger effectiveness and heat transfer rate
5. To determine Calibration of thermocouple
6. To determine Experimental determination of Stefen- Boltzman constant

MEA-603 (A)	**IC Engines**	**3L:1T:0P**	**04 credits**	**4 Hrs/Week**

Course Preamble:

1. To make students familiar with the design and operating characteristics of modern internal combustion engines
2. To apply analytical techniques to the engineering problems and performance analysis of internal combustion engines
3. To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions
4. To introduce students to the environmental and fuel economy challenges facing the internal combustion engine
5. To introduce students to future internal combustion engine technology and market trends

Course Outcomes:

1. Differentiate among different internal combustion engine designs
2. Recognize and understand reasons for differences among operating characteristics of different engine types and designs
3. Given an engine design specification, predict performance and fuel economy trends with good accuracy
4. Based on an in-depth analysis of the combustion process, predict concentrations of primary exhaust pollutants

UNIT I

Internal Combustion Engine: S.I. and C.I. engines of two and four stroke cycles, real cycle analysis of SI and CI engines, determination of engine dimensions, speed, fuel consumption, output, mean effective pressure, efficiency, factors effecting volumetric efficiency, heat balance, performance characteristics of SI and CI engines, cylinder arrangement, firing order, power balance for multi-cylinder engines, valve timing.

(10 hours)

UNIT 2

Combustion in SI engines: Flame development and propagation, ignition lag, effect of air density, temperature, engine speed, turbulence and ignition timings, physical and chemical aspects of detonation, effect of engine and fuel variables on knocking tendency, knock rating of volatile fuels, octane number, H.U.C.R., action of dopes, pre-ignition, its causes and remedy, salient features of

various type combustion chambers, valve timing and firing order.

(9 hours)

UNIT 3

Combustion in C.I. Engines: Times base indicator diagrams and their study, various stages of combustion, delay period, diesel knock, octane number, knock inhibitors, salient features of various types of combustion chambers, fuel, ignition, cooling, exhaust and lubrication systems; Simple problems on fuel injection, various types of engines, their classification and salient features. Rotary I. C. engines, their principles of working.

(9 hours)

UNIT 4

I.C. Engine System: Fuels, ignition systems, cooling, exhaust/scavenging and lubrication system. Fuel metering in SI engine: Fuel injection in SI engine (MPFI & TBI), Theory of carburetion, simple problems on carburetion. Fuel metering in CI engines: Fuel injection in CI engine and simple problems, various types of engines, their classification and salient features. Fuels: Conventional fuels and alternate fuels, engine exhaust emission, carbon monoxide, unburnt hydro carbon, oxides of nitrogen, smoke, density, measurement and control, hydrogen as alternate fuel.

(10 hours)

UNIT 5

Supercharging: Effect of attitude on mixture strength and output of S.I. engines, low and high pressure super charging, exhaust, gas turbo-charging, supercharging of two stroke engines.

(8 hours)

References:

1. Ganeshan V; Internal Combusion engines; TMH
2. Mathur ML & Sharma RP; A. Course in IC engines; DhanpatRai
3. Gupta HN; Fundamentals of IC Engines; PHI
4. Srinivasan S; Automotive Engines; TMH
5. Halderman JD and Mitchell CD; Automotive Engines theory and servicing; Pearson
6. DomKundwar; Internal Combustion Engines ; Dhanpat Rai Publications
7. Taylor GF; Internal Combustion Engines Theory & Practice; MIT Press
8. Richard Stone; Introduction to IC Engines; Society of Automotive Engr (Palgrave Mc Millan)

MEA-603 (B)	**MECHANICAL MEASUREMENT AND CONTROL**	**3L:1T:0P**	**04 credits**	**4 Hrs/Week**

Course Preamble:

1. To understand the basic principles, construction and working of engineering mechanical measurement science.
2. To acquire proficiency in using, calibrating various measurement systems
3. To understand the problems in measurement system and develop the competency to resolve the problems.
4. To know all the measuring instruments and to measure different parameters in day-today work.

Course Outcomes:

After going through basic study of generalized measurement system, students will be able

1. To understand the stepwise working of all instruments and will be able to find out the output factors.
2. They will be able to know the importance of all factors affecting on output of instruments
3. They can suggest some points in the design & working of instruments after studying the basics if metrology.
4. Students will be able to differentiate between all types of measurements i.e. Direct & indirect type, contact & non-contact type as well as they can design the components with provisions of tolerance in manufacturing through the concepts of metrology.

UNIT 1

Measurement: Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs. Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc. Errors in measurement: Types of errors, Effect of component errors, Probable errors. **(10 hours)**

UNIT 2

Displacement Measurement : Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder) **Strain Measurement :** Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors **Measurement of Angular Velocity:** Tachometers, Tachogenerators, Digital tachometers and Stroboscopic Methods, Acceleration Measurement.

(9 hours)

UNIT 3

Pressure Measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges. Flow Measurement: Bernoulli‟s flow meters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter. Temperature Measurement: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers.

(10 hours)

UNIT 4

Introduction to control systems, Classification of control system, Open loop and closed loop systems, Mathematical modelling of control systems, concept of transfer function, Block diagram algebra.

(8 hours)

UNIT 5

Transient and steady state analysis of first and second order system . Time Domain specifications. Step response of second order system. Steady-state error ,error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs.

(8 hours)

References:

1. Measurement Systems (Applications and Design) 5th ed.- E.O. Doebelin - McGraw Hill.
2. Mechanical Engineering Measurement - Thomas Beckwith, N.Lewis Buck, Roy Marangoni Narosa Publishing House, Bombay.
3. Mechanical Engineering Measurements - A. K. Sawhney - DhanpatRai& Sons, New Delhi.
4. Instrumentation Devices & Systems - C.S. Rangan&G.R.Sarrna - Tata McGraw Hill.
5. Instrumentation & Mechanical Measurements - A.K. Thayal.
6. Control System Engineering: by Nagrath IJ. and Gopal .

MEA-604 (A)	Power Plant Engineering	3L:0T:0P	03 credits	3Hrs/Week

Course Preamble:

1. To develop an ability to apply knowledge of Mathematics and Thermal Sciences
2. To develop an ability to design a system component and processes to meet the desired needs of Power Plant.
3.

Course Outcomes:

1. Ability to have adequacy with design, erection and development of Power Plant
2. Optimization of Power Plants with respect to available resources.

Unit I

Introduction to methods of converting various energy sources to electric power, direct conversion methods renewable energy sources, solar, wind, tidal, geothermal, bio-thermal, biogas and hybrid energy systems, fuel cells, thermoelectric modules, MHD-Converter.

(9 hours)

Unit II

Fossil fuel steam stations: Basic principles of sitting and station design, effect of climatic factors on station and equipment design, choice of steam cycle and main equipment, recent trends in turbine and boiler sizes and steam conditions, plant design and layout, outdoor and indoor plant, system components, fuel handling, burning systems, element of feed water treatment plant, condensing plant and circulating water systems, cooling towers, turbine room and auxiliary plant equipment., instrumentation, testing and plant heat balance.

(10 hours)

UNIT III

Nuclear Power Station: Importance of nuclear power development in the world and Indian context, Review of atomic structure and radio activity, binding energy concept, fission and fusion reaction, fissionable and fertile materials, thermal neutron fission, important nuclear fuels, moderators and coolants, their relative merits, thermal and fast breeder reactors, principles of reactor control, safety and reliability features.

(9 hours)

Unit IV

Hydro-Power Station: Elements of Hydrological computations, rainfall run off, flow and power duration curves, mass curves, storage capacity, salient features of various types of hydro stations, component such as dams, spillways, intake systems, head works, pressure tunnels, penstocks, reservoir, balancing reservoirs, Micro and pico hydro machines, selection of hydraulic turbines for power stations, selection of site.

(9 hours)

Unit V

Power Station Economics: Estimation and prediction of load. Maximum demand, load factor, diversity factor, plant factor and their influence on plant design, operation and economics; comparison of hydro and nuclear power plants typical cost structures, simple problems on cost analysis, economic performance and tariffs, interconnected system and their advantages, elements of load dispatch in interconnected systems.

(9 hours)

References:

1. Nag PK; Power plant Engg; TMH
2. Al-Wakil MM; Power plant Technology; TMH
3. Sharma PC; Power plant Engg; Kataria and sons, Delhi
4. Domkundwar; Power Plant Engg; Dhanpatrai & sons.
5. Rajput RK; A text book of Power plant Engg.; Laxmi Publications.
6. Yadav R; Steam and gas turbine and power plant engg.

MEA-604 (B)	Renewable Energy System	3L:0T:0P	03 credits	3Hrs/Week

Course Preamble:

The course should enable the students to:

1. Understand the various forms of conventional energy resources.
2. Learn the present energy scenario and the need for energy conservation
3. Explain the concept of various forms of renewable energy
4. Outline division aspects and utilization of renewable energy sources for both domestics and industrial application
5. Analyze the environmental aspects of renewable energy resources.

Course Outcome:

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

1. Describe the environmental aspects of non-conventional energy resources. In Comparison with various conventional energy systems, their prospects and limitations.
2. Know the need of renewable energy resources, historical and latest developments.
3. Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.
4. Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.
5. Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications
6. Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations.
7. Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and applications.

UNIT-I

Solar Radiation: Extra-terrestrial and terrestrial, radiation measuring instrument, radiation measurement and predictions. **Solar thermal conversion**: Basics, Flat plate collectors-liquid and air type. Theory of flat plate collectors, selective coating, advanced collectors, Concentrators: optical design of concentrators, solar water heater, solar dryers, solar stills, solar cooling and refrigeration. **Solar photovoltaic**: Principle of photovoltaic conversion of solar energy; Technology for fabrication of photovoltaic devices; Applications of solar cells in PV generation systems; Organic PV cells.

(10 hours)

UNIT-II

Wind energy characteristics and measurement: Metrology of wind speed distribution, wind speed statistics, Weibull, Rayleigh and Normal distribution, Measurement of wind data, Energy estimation of wind regimes;

Wind Energy Conversion: Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics; power curve of wind turbine, capacity factor, matching wind turbine with wind regimes; Application of wind energy wind turbine with wind regimes**;** **(9 hours)**

UNIT-III

Production of biomass- photosynthesis-C3 & C4 plants on biomass production; Biomass resources assessment; Co2 fixation potential of biomass; Classification of biomass; Physicochemical characteristics of biomass as fuel **Biomass conversion** routes: biochemical, chemical and thermo chemical Biochemical conversion of biomass to energy: anaerobic digestion, biogas production mechanism, technology, types of digesters, design of biogas plants, installation, operation and maintenance of biogas plants, biogas plant manure-utilization and manure values. Biomass Gasification: Different types, power generation from gasification, cost benefit analysis of power generation by gasification.

(10 hours)

UNIT-IV

Small Hydropower Systems: Overview of micro, mini and small hydro system; hydrology; Elements of turbine; Assessment of hydro power; selection and design criteria of turbines; site selection and civil works; speed and voltage regulation; Investment issue load management and tariff collection; Distribution and marketing issues. **Ocean Energy:** Ocean energy resources, ocean energy routs; Principle of ocean thermal energy conversion system, ocean thermal power plants. Principles of ocean wave energy and Tidal energy conversion.

(8 hours)

UNIT-V

Geothermal energy: Origin of geothermal resources, type of geothermal energy deposits, site selection geothermal power plants; **Hydrogen Energy**: Hydrogen as a source of energy, Hydrogen production and storage. **Fuel Cells**: Types of fuel cell, fuel cell system and sub- system, Principle of working, basic thermodynamics.

(8 hours)

References:

1. Kothari, Singal & Rajan; Renewable Energy Sources and Emerging Technologies, PHI Learn
2. Khan, B H, Non Conventional Energy, TMH.
3. Sukhatme and Nayak, Solar Energy, Principles of Thermal Collection and Storage, TMH.
4. Tiwari and Ghosal, Renewable Energy Resources: basic principle & application, Narosa Publ
5. Koteswara Rao, Energy Resources, Conventional & Non-Conventional, BSP Publication.
6. Chetan Singh Solanki, Solar Photovoltaics: Fundamental, technologies and Application,PHI L
7. Abbasi Tanseem and Abbasi SA; Renewable Energy Sources; PHI Learning
8. Ravindranath NH and Hall DO, Biomass, Energy and Environment, Oxford University Press.
9. Duffie and Beckman, Solar Engineering of Thermal Process, Wiley.

MEA-605 (A)	Operation Research	3L:0T:0P	03 credits	3Hrs/Week

Course Preamble:

1. Identify and develop operational research models from the verbal description of the real system.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.
4. Develop a report that describes the model and the solving technique, analyze the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

Course Outcome

1. Methodology of Operations Research.
2. Linear programming: solving methods, duality, and sensitivity analysis.
3. Integer Programming.
4. Network flows.
5. Multi-criteria decision techniques.
6. Decision making under uncertainty and risk.
7. Game theory.
8. Dynamic programming.

UNIT 1

Linear system and distribution models: Mathematical formulation of linear systems by LP, solution of LP for two variables only, special cases of transportation and assignment and its solution, Vogel‟s forward looking penalty method, cell evaluation degeneracy, use of SW Lindo, Tora, Excell.

(8 hours)

UNIT 2

Supply chain (SCM): Definition, importance, expenditure and opportunities in SCM; integration of inbound, outbound logistics and manufacturing to SCM, flow of material money and information, difficulties in SCM due to local v/s system wide (global) optimization and uncertainties in demand and transportation; Bull-whip effect; customer value; IT, info-sharing and strategic partnerships; plant and warehouse-network configuration; supply contracts and revenue sharing; outsourcing; transportation, cross docking and distribution, forecasting models in SCM; coordination and

leadership issues; change of purchasing role and vendor rating, variability from multiple suppliers.

(10 hours)

UNIT 3

Inventory models: Necessity of inventory in process and safety stock, problem of excess inventory and cycle time (=WIP/ Throughput), JIT/ lean mfg; basic EOQ/ EPQ models for constant review Q-system(S,s); periodic review, base stock P-system; service level, lead time variance and safety stock; ABC, VED and other analysis based on shelf life, movement, size, MRP technique and calculations, lot sizing in MRP, linking MRP with JIT; evolution of MRP to ERP to SCM and e-business.

(9 hours)

UNIT 4

Waiting Line Models Introduction, Input process, service mechanism, Queue discipline, single server (M/M/1) average length and times by Littles formula, optimum service rate; basic multiple server models (M/M/s) (b) **Competitive strategy**: concept and terminology, assumptions, pure and mixed strategies, zero sum games, saddle point, dominance, graphical, algebraic and LP methods for solving game theory problems.

(9 hours)

UNIT 5

Decision analysis: decision under certainty, risk probability and uncertainty; Hurwicz criteria; AHP-assigning weight and consistency test of AHP **(**b**) Meta-heuristics** Definition of heuristic and meta-heuristic algorithms; introduction to Tabu search, Simulated Annealing and Genetic algorithms and solution of traveling salesman and non linear optimization problems.

(9 hours)

References:

1. Hillier FS and Liberman GJ; Introduction to Operations Research concept and cases; TMH
2. Simchi-Levi, Keminsky; Designing and managing the supply chain; TMH.
3. Srinivasan G; Quantitative Models In Operations and SCM; PHI Learning
4. Mohanty RP and Deshmukh SG; Supply Chain Management; Wiley India
5. Taha H; Operations research; PHI
6. Sen RP; Operations Research-Algorithms and Applications; PHI Learning
7. Sharma JK; Operations Research; Macmillan
8. Ravindran , Philips and Solberg; Operations research; Wiley India
9. Vollman, Berry et al; Manufacturing planning and control for SCM; TMH.
10. Bowersox DJ, Closs DJ, Cooper MB; Supply Chain Logisti Mgt; TMH
11. Burt DN, Dobler DW, StarlingSL; World Class SCM; TMH

MEA-605 (B)	Ergonomics Engineering	3L:0T:0P	03 credits	3Hrs/Week

Course Preamble:
This course introduces the role of Work Study in the industry and how productivity issues in the industry can be addressed by the application of Work Study, while stimulating critical thinking on the techniques of Method Study and Work Measurement. The course also introduces the concept of conducting time studies and production studies to assess time standards and production standards for fulfilling production goals in an organization.

Course Outcome:
The students will be able to:

1. develop a case for productivity improvement in any manufacturing or service industry scenario
2. Independently conduct a method study in any organization with the objective of improving a process, material movement system or design of a work place
3. develop time standards for operations, identify production bottlenecks and improvise operations
4. apply principles of good ergonomic design of work areas and equipment
5. Identify, explain and evaluate the impact of various personal attributes (anatomical, physiological and anthropometric) on proper safe working practice

UNIT 1

General: Man in industrial work environments, Ergonomics as multidisciplinary fields, Importance and justification and ergonomics problems, Man-machine-environment system.

(8 hours)

UNIT 2

Anthropometry: Significance of human body measurement in design of equipment, Facilities, Work place and operation, Static and dynamic anthropometry, Anthropometric data. **Task Analysis:** Task description, Posture measurement, RULA & REBA analysis and evaluation, Lifting & lowering tasks, Lifting index, Lifting & carrying tasks, NIOSH lifting equation.

(9 hours)

UNIT 3

Biomechanics: Introduction to levers of Human Body, Ligaments & Tendons, Joints. Kinetics to include forces producing motion.

(8 hours)

UNIT 4

Man-Environment Interface: Environmental factors of temperature, Humidity, Lighting and noise in industry, Effect of environmental factors on human performance, Measurement and mitigation of physical and mental fatigue, Basics of environment design for improved efficiency.

(9 hours)

UNIT 5

Design of Display and Control: Need for information display, Elements of information theory, Reaction time, Methods and types of displays, Design of audio and visual displays, Design of hand and foot operated control device, Design of human-computer interface.

(9 hours)

References:

1. Bridger, R.S., Introduction to Ergonomics, McGraw Hill (2008).
2. Sanders, M. and McCormick E., Human Factors in Engineering & Design, McGraw Hill (1993).
3. Maynard, H. B., Industrial Engineering Hand Book, McGraw Hill (1992).
4. David, A., Practice & Management of Industrial Ergonomics, Prentice Hall (1986).
5. Singleton, W. T., Introduction to Ergonomics, WHO, Geneva (1972).

MEA-606 Minor Project

Objectives of the course Minor Project are :

To provide students with a comprehensive experience for applying the knowledge gained so far by studying various courses. To develop an inquiring aptitude and build confidence among students by working on solutions of small industrial problems. To give students an opportunity to do something creative and to assimilate real life work situation in institution. To adapt students for latest development and to handle independently new situations. To develop good expressions power and presentation abilities in students.

The focus of the Minor Project is on preparing a working system or some design or understanding of a complex system using system analysis tools and submit it the same in the form of a write up i.e. detail project report. The student should select some real life problems for their project and maintain proper documentation of different stages of project such as need analysis market analysis, concept evaluation, requirement specification, objectives, work plan, analysis, design, implementation and test plan. Each student is required to prepare a project report and present the same with a demonstration of the working system (if any)

Working schedule the faculty and student should work according to following schedule:

Each student undertakes substantial and individual project in an approved area of the subject and supervised by a member of staff. The student must submit outline and action plan for the project execution (time schedule) and the same be approved by the concerned faculty.

Action plan for Minor Project work and its evaluation scheme (Suggestive)

Task/Process	Week	Evaluation	Marks For Term Work
Orientation of students by HOD/Project Guide	1st	-	-
Literature survey and resource collection	2nd	-	-
Selection and finalization of topic before a Committee*	3rd	Seminar-I	20
(Detailing and preparation of Project) Modeling, Analysis and Design of Project work	4th to 5th	-	20
Testing, improvements, quality control of project	6th to 10th - 11th	-	25
Report Writing	12th to 15th		25
Presentation before a committee (including user manual, if any)	16th	Seminar-II	30

* Committee comprises of HOD, all project supervisions including external guide from Industry (if any)

NOTE: At every stage of action plan, students must submit a write up to the concerned guide.