SCHEME OF INSTRUCTION & EXAMINATION

AICTE Model Curriculum

B. E. VII – Semester (PRODUCTION ENGINEERING)

(wef: 2021-2022)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Wee	CIE	SEE	Duration in Hours	
Theory Course										
1	PC701PE	Tool Design	3	-	-	3	30	70	3	3
2	PC702ME	Modern Machining & Forming Methods	3	-	-	3	30	70	3	3
3	PE-PE-III	Professional Elective-III	3	-	-	3	30	70	3	3
4	PE-PE-IV	Professional Elective-IV	3	-	-	3	30	70	3	3
5	OE-II	Open Elective-II	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
6	PW702ME	Project -I	-	-	6	6	50			3
Total										**18**

PROFESSIONAL ELECTIVE - III		
S. No.	**Course Code**	**Course Title**
1	PE711PE	Product Design & Process Planning
2	PE712PE	Production & Operation Management
3	PE713PE	Operations Research

PROFESSIONAL ELECTIVE - IV		
S. No.	**Course Code**	**Course Title**
1	PE721PE	Robotics Engineering
2	PE722PE	Metal Forming Technology
3	PE723PE	Non-Conventional Energy Sources

Open Elective – II		
1	**OE701 CE**	Green Building Technologies (Not for Civil Engg students)
2	**OE701 CS**	Data science and Data Analytics (Not for CS students)
3	**OE701 EE**	Non Conventional Energy Sources (Not for EEE & EIE Students)
4	**OE701 EC**	Fundamentals of IoT (Not for ECE Students)
5	**OE701 IT**	Cyber security (Not for IT students)
6	**OE701 ME**	Start-up Entrepreneurship (Not for Mech/Prod Engg students)
7	**OE701AE**	Automotive Maintenance (Not for Automobile Engineering)

PC: Professional Core **PE:** Professional Elective **OE: Open Elective**

L: Lecture **T:** Tutorial **P**: Practical **D:** Drawing

CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

Code: PC701PE

TOOL DESIGN
(Professional Core Course)
Credits: 3

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*

Course Objectives:

1. Various forces involved in the machining operations
2. heat generation in machining & coolant operation
3. tools, jigs and fixture, suitable for a particular machining operation

Course Outcomes:

1. Calculate the values of various forces involved in the machining operations
2. Design various single and multipoint cutting tools
3. Analyse heat generation in machining & coolant operation
4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
5. Identify appropriate combination of tools, jigs and fixture, suitable for a particular machining operation
6. Design assembly of jigs and fixtures on simple work-piece

Unit-I

Cutting tool materials and processes: Desired properties, Types, major constituents, relative characteristics, latest developments, ISO: Classification and coding of carbide tools, Coated tools. Principles of working and applications of USM, EDM, ECM, AJM, LBM, and EBM. Super finishing processes: Honing, Lapping Burnishing, Ballizing, Polishing

Unit-II

Design of single point cutting tools, Form Tools: Design of flat and circular Form Tools and tool holding methods. Design of Multi Point Cutting tools: Milling Cutters: Major types, design and manufacturing of peripheral, end and face milling cutters, forces and power estimation. Grinding of milling cutters. Broaches: Pull and Push types. Internal and External broaches, geometry
and design and manufacturing of Pull type and push type broaches.

Unit-Ill

Multi point cutting tools: Twist Drill geometry, Design and manufacturing of twist drill. Effect of variation of different angles on torque and thrust forces. Types and design of shanks. Sharpening of twist drill. Reamers: Types, geometry, Reaming allowance, tolerance disposition, Design and manufacture of twist drills. Taps and Dies: Types, Geometry, Design and manufacturing of Taps and Dies.

Unit-IV

Locating and clamping principles, locating guide lines, Determining locator size and tolerances, clamping guide lines, factors in selecting clamps, positioning the clamps, selecting clamp size and forces.

Unit-V

Jigs & Fixtures: Design principles of Jigs & Fixtures , construction features, purpose and advantages. Principle of location, types of jigs and fixtures ,Locating methods associated with

flat, cylindrical, internal and external surfaces. Type of locating pins. Requirements and choice of locating systems. Redundant location, fool proofing.

Suggested Reading:

Donaldson, Leain and Goold, *Tool Design,* Tata Me Graw Hill, New Delhi, 1983.
Rodin, Design *of Cutting Tools,* Mir Publications, Moscow.
Amitabha Battacharya and Inyong Ham, *Design of Cutting Tool,* Use Of Metal Cutting Theory, ASTME Publication Michigan USA, 1969.
Surender Keshav & Umesh Chandra, *Production Engineering* Design (Tool Design), Satya Prakashan, New Delhi-1994

Code: PC702PE

MODERN MACHINING AND FORMING METHODS
(Professional Core Course)

Credits: 3

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*

Course Objectives:

1. To understand the importance and have knowledge of Unconventional machining and forming processes.
2. To have the knowledge of different micro machining methods..
3. To understand the working principles of various Non-traditional methods in machining and forming

Course Outcomes:

1. Gain the knowledge on various Non-traditional machining methods which are applicable for difficult-to-cut materials, defence and aerospace sectors..
2. Decide on the process parameters to be adopted and applicability of various materials that are suitable for mechanical energy based machining processes.
3. Decide on the process parameters to be adopted and applicability of various materials that are suitable for electrical and thermal based machining processes.
4. Decide on the process parameters to be adopted and applicability of various materials that are suitable for chemical and electro-chemical energy based machining processes.

Unit-I

Ultrasonic Machining (USM): Introduction, process description, abrasive slurry, Abrasive materials and their characteristics. Functions of liquid medium in slurry, Types of Transducers, effect of process parameters, applications and limitations. Abrasive Jet Machining (AJM): Principle of operation, process details, process variables and their effect on MRR and accuracy. Equation for MRR. Advantages, disadvantages and applications. Water Jet Machining (WJM): Schematic diagram, equipment used, advantages and applications

Unit-II:

Electro Discharge Machining (EDM): Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, over cut and side taper' Flushing, Mechanism of metal removal, crater volume, types of power supply circuits, mathematical analysis of metal removal rate (MRR), characteristics of spark eroded surfaces, advantages, disadvantages and applications. Wire EDM: Process description and applications. Electro-Chemical Machining (ECM): Schematic of the process parameters, function and characteristics of electrolyte, chemistry of the process, Equation for specific MRR and electrode feed rate, advantages, limitations and applications., Rotary Machining, Hot machining, high speed machining, description of each process, process parameters, advantages and applications.

Unit-III

LASER Beam Machining (LBM): Principle of LASER Beam production, materials used, thermal analysis of the process, process parameters, equations for power density and machining rate,

advantages, limitations and applications. Plasma Arc Machining (PAM): Introduction equipment used, process description and parameters, types of plasma arc; Transferred arc and non transferred arc and process applications. Electron Beam Machining (EBM): Schematic of the process, process parameters, principle of production of Electron beam, equipment used, Advantages, disadvantages and applications.ION Etching: Process description and applications.

Unit-IV

Rubber Pad Forming: Principle of the process, process details and its types; Guerin, wheel on, Marfoming and Hydro forming processes and applications. Electro-Hydraulic forming (EHF): Schematic of the process description and its applications. High Energy Rate Forming (HERF): HERF

hammers, principle of explosive forming, Explosive materials, types of explosive forming, stand off operation and contact operation, the pressure pulse, Gas bubble and the process applications

Unit-V

Stretch Forming: Introduction, types of stretch forming: stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming. Stretch forming equipment and accessories, accuracy and surface finish, process variables and limitations. Tube spinning:

Introduction, methods of tube spinning, Backward spinning, Forward spinning, machines and tools used. Machine variables, speeds and feeds, effect of tube spinning on work metal properties and applications. Hydrostatic Forming: Process principle, description and applications. Water Hammer Forming (WHF): Schematic diagram of the process, principle of operation, process variables, work materials, process limitations and applications

Suggested Reading:

1. P.C. Pandey andH.S. Shah, *Modern Machining Process,* Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980.

2. A. Bhatacharya, *New Technology*, The Institution of Engineers (India), 1984.

3. Davies and Austin, *Developments in High Speed Metal Forming,*The Machinery Publishing Co. Ltd., 1985

4. *Production Technology,* HMT

Code: PC711PE

PRODUCT DESIGN AND PROCESS PLANNING
(Professional Elective-III)

Credits: 3

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*

Objectives:

A student shall understand

1. The Product Design and Process Functions
2. The essence of innovation in product development
3. The Human Machine Interactions (ergonomics)
4. The various Intellectual Property Rights
5. The interaction between Design, Manufacturing, Quality and Marketing
6. The awareness about overall view of Process Planning

Outcomes:

At the end of the course, the students will be able to

1. Identify the functions of design of a product in a system in a given situation and select a suitable product; identify the procedure for technological innovation of a product; explain the importance of brainstorming and Delphi techniques in innovation
2. Explain the importance of design, human machine interaction in project selection and evaluation methods including ergonomic considerations
3. Explain the importance of research in new product development; describe the process of patenting including search of patents, patent laws and international code and discriminate the scope of IPR for a product patent.
4. Discuss the features of design of a new product with respect to manufacture, quality testing and marketing; and steps to evaluate a new product for introduction;
5. Develop process planning including creating process sheets; explain value engineering, group technology and concurrent engineering in the selection of manufacturing process.

Unit-I

Product Design and Process Design functions. Selection of right product. Systematic procedure of product innovation. Factors contributing to successful technological innovation - need for creativity and innovation. Techniques of innovation like brain storming and Delphi techniques.

Unit-II:

Project Selection and Evaluation: Function of design - Design with Human Machine Interaction (HMI). Collection of ideas and purpose of project. Selection criteria - screening ideas for new products using evaluation techniques. Principles of ergonomics.

Unit-III

New Product Development: Research and new product development. Patents, definitions, patent search, patent laws, international code for patents -Intellectual Property Rights (IPR).

Unit-IV

New - Product Planning: Interaction between the functions of design, manufacture, quality & testing and marketing. Steps for introducing new products after evaluation. Product Design Practice and Industry – *Product Strategies, Analysis of the Product, The Three S's.*

Unit-V

Process-Planning: Process planning, process sheets. Selection of manufacturing process, estimation of machining time in various cutting operations - estimation of costs for manufacture. Value engineering in
product design, group technology, concepts of concurrent engineering.

Suggested Reading:

1. Niebel BW & DraperAB: "*Production Design & Process Engg*.", McGraw Hill, Kogakusha, 1974.
2. Chitale, A. K & Gupta R.C., "*Product Design & Manufacturing*" -PHI, 1997
3. Harry Nystrom, "*Creativity and Innovation*", John Wiley & Sons, 1979.
4. Brain Twiss, "*Managing Technological Innovation*", Pittman Publ, 1992.
5. Harry, B. Waton, "*New Product Planning*", Prentice Hall Inc., 1992
6. G Dieter, "*Engineering Design - a materials and processing approach*", McGraw Hill, NY, 2000

Code: PC712PE

PRODUCTION AND OPERATION MANAGEMENT
(Professional Elective-III)

Credits: 3

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*

Objectives:

1. To understand the concept of Production & Operations Management.
2. To understand role of work study and work measurement in Industry.
3. To learn use of forecasting and various methods of it.
4. To understand importance Aggregate planning, Materials Requirement Planning for Industry.
5. To understand Project Management approaches in completion of Project.

Outcomes:

1. Explain various types of Production Systems, develop suitable layout for a given plant
2. Develop various methods for work study and apply suitable Recording techniques. Develop standard procedures and time for the operations.
3. Explain necessity of Forecasting and various methods of it. Develop suitable quantitative forecasting technique for the given past data. Compare accuracy of models in connection with forecast errors.
4. Explain Aggregate planning & Mater scheduling, Materials Requirement Planning Processes. Develop quantitative models for Material requirement and resources based on time span.
5. Elaborate the usages of PERT/CPM techniques for a give project and develop suitable quantitative model for the project in successful competition by identifying the time constraints for start and endof process activities.

Unit-I

Production & Operations Management: Introduction, Types of production Systems. Job shop, Batch, Flow shop.

Plant location and layout: Factors affecting plant location, Break even analysis, plant layout objectives, Types of layouts, merits and demerits.

Unit-II:

Work Study: Introduction to method study, Steps in method study, Recording techniques- Flow process chart, String diagram, Therbligs, Principles of motion economy.

Work measurement: Stop watch time study, Standard time calculation. Work sampling-procedure, applications, advantages and disadvantages, Wages and incentives, types of incentive plans.

Unit-III

Forecasting: Introduction, Forecasting objectives and uses, demand patterns, Qualitative models Market survey, Delphi Tech, Quantitative models, Moving average, Weighted

moving average, Simple exponential smoothing, trend adjusted exponential smoothing, Least square method, Simple regression, multiple regression.
Forecast errors: Mean absolute Deviation (MAD), Mean Square Error (MSE), Mean Forecast Error(MFE), Mean absolute percentage error (MAPE).

Unit-IV

Aggregate Planning and Master Scheduling: Introduction, objectives of aggregate planning, Cost in aggregate planning, Strategies in aggregate planning, Master production scheduling.
Materials Requirement Planning MRP 1: Importance of MRP, MRP system inputs and outputs, MRP calculations

Manufacturing Resource Planning MRP 2 & Enterprise Resource Planning (ERP): Features of ERP packages like SAP, BANN, People soft etc.,

Unit-V

Project Management: Project management: Network fundamentals, difference between PERT/CPM Scheduling the activities. Fulkerson's rule. Earliest and latest times. Determination of ES and EF in the forward path. LS and LF in backward path. Determination of critical path. Free float, independent float, Total float, Program evaluation and review technique, crashing of network.

Suggested Reading:

1. Joseph Monk, *Operations Management*, TMH Publishers, New Delhi, 2004.
2. Buffa Elwood S, *Modern Production / Operations Management,* John Wiley Publishers, Singapore, 2002.
3. Everett E Adam, Jr and Ronald J. Ebert, *Production and Operations Management – Concepts, Models and Behaviour,* 5th Ed. 1998, (EEE), Prentice Hall of India(P) Ltd., NewDelhi.
4. Panneer Selvam R, "*Operations Research*", Second Edition, PHI Learning Pvt. Ltd. New Delhi, 2006.
5. S.D. Sharma, "*Operations Research*", Kedarnnath, Ramnath & Co., Meerut, 2009.

Code: PC713PE

OPERATION RESEARCH
(Professional Elective-III)

Credits: 3

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*

Objectives:

1. To use variables for formulating complex mathematical models in management science, industrial engineering and transportation models.
2. To use the basic methodology for the solution of linear programming problems.
3. To understand the mathematical tools that are needed to solve optimization problems like Transportation models and Assignment models.
4. To understand the replacement models with change in money value considering with time and without time.
5. To Model a system as a queuing model and compute important performance measures.

Outcomes:

After completing this course, the student will be able to:

1. To prepare the students to have the knowledge of Linear Programming Problem in Operations Research at the end students would be able to understand the concept and develop the models for different applications.
2. To make students understand the concept Replacement models at the end students would able to explain various features and applications of replacement models in real time scenario.
3. To prepare the students to understand theory of Game in operations research at the end students would able to explain application of Game theory in decision making for a conflict.
4. To prepare the students to have the knowledge of Sequencing model at the end student would able to develop optimum model for job scheduling.
5. To prepare students to understand Queuing theory concepts and various optimization techniques at the end students would able to develop models for waiting line cases.

Unit-I

Introduction: Definition and Scope of Operations Research.
Linear Programming: Introduction, Formulation of linear programming problems, graphical method of solving LP problem, simplex method, maximization and minimization, Degeneracy in LPP, Unbounded and, Infeasible solutions.

Unit-II:

Duality: Definition, Relationship between primal and dual solutions, Economic Interpretation, Post optimal of sensitivity analysis, Dual Simplex Method.

Unit-III

Transportation Models: Finding an initial feasible solution - North West corner method, least cost method, Vogel's Approximation method, Finding the optimal solution, optimal solution by stepping stone and MODI methods, Special cases in Transportation problems - Unbalanced Transportation problem.
Assignment Problems: Hungarian method of Assignment problem, Maximization in Assignment problem, unbalanced problem, problems with restrictions, travelling

salesman problems.

Unit-IV

Replacement Models: Introduction, replacement of items that deteriorate ignoring change in money value, replacement of items that deteriorate considering change in money value with time, replacement of items that fail suddenly - Individual replacement policy, Group replacement policy.

Game Theory: Introduction, 2 person zero sum games, Maximin - Minimax principle, Principle of Dominance, Solution for mixed strategy problems, Graphical method for 2 x n and m x 2 games.

Unit-V

Sequencing Models: Introduction, General assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines, Processing 2 jobs through m machines

Queuing Theory: Introduction, single channel - Poisson arrivals - exponential service times with infinite population & finite population, Multi channel - poison arrivals - Exponential service times with infinite population.

Introduction to Optimization Techniques: Single objective & Multi objective optimization Techniques like G.A, NSGA, P.Q.O & MPSO Techniques.

Suggested Reading:

1. Hamdy, A. Taha, "*Operations Research-An Introduction*", Sixth Edition, Prentice Hall of India Pvt. Ltd., 1997.
2. S.D. Sharma, "*Operations Research*", Kedarnath, Ramnath & Co., Meerut, 2009.
3. Hrvey M. Wagner, "*Principles of Operations Research*", Second Edition, Prentice Hall of India Ltd., 1980.
4. V.K. Kapoor, "*Operations Research*", S. Chand Publishers, New Delhi, 2004.
5. R. Paneer Selvam, "*Operations Research*", Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2008.
6. Data Reconciliation by Prof. Shanker Narasimha.

Code: PC721PE

ROBOTIC ENGINEERING
(Professional Elective-IV)
Credits: 3

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*

Objectives:

Students will understand

1. The configuration, work envelop and motion controls and applications
2. Familiarities with the kinematics of robots.
3. Robot end effectors and their design.
4. Familiarities with the dynamics of robots.
5. Robot Programming methods & Languages of robot.
6. Various Sensors and drives and their applications in robots

Outcomes:

At the end of the course, the students will be able to

1. Identify and classify various robot configurations with their workspaces, recognize and find suitable robot for a particular Industrial application considering their Degrees of freedom, type of end effector and other Specifications.
2. Able to use rotation matrices and perform forward kinematic operations. Find Jacobean in velocity domain.
3. Able to perform inverse kinematics and convert a world space problem to joint space problem. Develop dynamical equations for control of robots.
4. Perform trajectory planning and implement independent joint control. Identify suitability of various control methods.
5. Interface various hardware and software components to develop robotic systems for industry& Evaluate their performance

Unit-I

Brief History, Types of robots, Overview of robot subsystems, Robot Joints and its Links, Degrees of freedom of robots, Work space of Robots, accuracy, precision, resolution and repeatability, Robot classification: Based on kinematic configurations, control methods, workspace. Different types of Wrists used in industrial robots. Different types of Robot Drives. End effectors and Grippers, Mechanical, Electrical, vacuum and other methods of gripping.

Robots used in various Industrial operations like Material handling, Assembly, Inspection, Welding and Painting. Description and Specifications in each case.

Unit-II:

Rotation matrices, Representation of location and orientation. Euler angle and RPY representation, Homogeneous transformation matrices Denavit-Hartenberg notation, representation of Translation and rotation in terms of joint parameters, Forward kinematics. Velocity Kinematics and Jacobian in Velocity domain.

Unit-III

Inverse Kinematis, inverse location, inverse orientation,inverse velocity, Singular

Configuration of robots , Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangian and Newton-Euler formulations of RR and RP type planar robots.

Unit-IV

Trajectory Planning: Joint interpolation,task space interpolation, executing user specified tasks, Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, Computed torque control, force control, hybrid control, neural network based control of manipulator, fuzzy control of manipulator, CNN based control of manipulator.

Unit-V

Sensors: types of sensors, tactile & non tactile sensors, sensors to measure Position, velocity & acceleration , Optical encoders. Range and Proximity sensing, acoustic, pneumatic, Hall effect sensor, Eddy current sensors, Force and Torque sensors.

Vision: Image acquisition, types & components of vision system, Image representation, digitisation, binary, gray scale, RGB representation, Image processing, Image segementation, image smoothening, object descriptors, object recognition.

Suggested Reading:

1. Spong and Vidyasagar, "Robot Dynamics & Control", John Wiley and Sons, Ed.,1990
2. Mittal and Nagrath, "Industrial Robotics", Tata McGraw Hill Publications, 2004.
3. Saha&Subirkumar saha, ‘Robotics’, TMH, India.
4. Asada and Sllotine , ‘Robot analysis and intelligence’ BS Publications , India.
5. Fu. K.S., GonZalez R.C., Lee C.S.G. "Robotics, Control-sensing vision and Intelligence", McGraw Hill, Int. Ed., 1987.
6. Groover M.P.,"Industrial Robotics", McGraw Hill Publications, 1999.
7. Robotics toolbox in MAT LAB.

Code: PC722PE

METAL FORMING TECHNOLOGY
(Professional Elective-IV)

Credits: 3

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*

Objectives:

1. To familiarize with plasticity, work hardening and cold and hot working of metals.
2. To understand the concept of yielding, plane stress-strain conditions.
3. To know the sheet metal operations and corresponding machinery of sheet metal working.
4. To understand the metal forming operations such as drawing, extrusion, foreign and rolling etc., and related forming machines.

Outcomes:

1. To understand work hardening of metals and explain hot working and cold working operations.
2. To distinguish between engineering stress-strain and true stress-strain, and identify the different yield criterion.
3. To estimate forces for sheet metal shearing operations and classify various presses and dies used
4. To discuss the working principles and operations of forging, rolling, drawing and extrusion processes.

UNIT-I

Theory of Plastic Deformation: Crysto plasticity and thermo plasticity, work hardening of metals, plasticity cycle. Advantages and disadvantages of cold working and hot working Stress strain relations, Yielding criteria, yielding under uni-axial, bi-axial and tri-axial states of stress. Plane stress and plane strain conditions, examples.

UNIT-II

Sheet Metal Working: Classification of presses, specifications and their applications. Sheet metal working operations-shearing, blanking, piercing, bending, drawing and squeezing operations, estimation of loads and energy required for these operations. Simple, compound, progressive and combinational tools

UNIT-III

Drawing and Extrusion: Loads required for drawing and extrusion. Homogenous deformation, maximum reduction in drawing and extrusion, Effect of friction, die angles, deformation speeds, die materials and lubricating in these operations. Stretch forming spinning and flow forming.

UNIT-IV

Forging: Methods of heating and furnaces Open and closed die forging. Hammers, presses and forging machines, their principles of operation and applications Examples, of the design of the forging dies for drop forging, Machine forging and press forging Isothermal forging and hot isostatic pressing

UNIT-V

Rolling: Principle of metal rolling, Classification and description of rolling equipment and rolling mills Roll load, roll torque and mill power following homogenous deformation

technique. Rolling procedure for typical shapes Powder rolling and Roll bending.

Suggested Reading:

1. Serope Kalpakjian, "Manufacturing Engineering and Technology" Addison-Wesley Publishing Company.
2. George. E. Dieter, "Mechanical Metallurgy" SI Metric Edition, McGraw-Hill Book Company
3. Jain, R.K and Gupta, S.C., "Production Technology" Khanna Publications, 1995.
4. Roy A. Liudberg, "Materials and Processes of Manufacture" Prentice Hall of India, 1995.
5. P.N. Rao, Manufacturing Technology, Tata McGraw Hill Publ., 2nd edition, 1990.
6. Pakirappa, "Production Technology" Durga Publishing House, Hyderabad, 2015.

Code: PC723PE

NON-CONVENTIONAL ENERGY SOURCES
(Professional Elective-IV)

Credits: 3

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*

Course Objectives:

1. To understand the concepts and applications of non-conventional energy sources.
2. To learn the principles of power generation - solar, wind, biomass, waste heat recovery

Course Outcomes: Students will be able to:

1. Select any Non-Conventional Energy Source equipment and apply concept of heat transfer and obtainthe results.
2. Able to design a wind mill.
3. Able to design a solar collector for different applications

UNIT-I

Statistics on conventional energy sources and supply in developing countries, Definition-Concepts of NCES, Limitations of RES, Criteria for assessing the potential of NCES. Classification of NCES- Solar, Wind, Geothermal, Bio-mass, Ocean Energy Sources, comparison of these energy sources.

UNIT-II

Solar Energy-Energy available form Sun, Solar radiation data, Solar energy conversion into heat, Flat plate and Concentrating collectors, Mathematical analysis of Flat plate collectors and collector efficiency, Principle of Natural and Forced convection, Solar engines-Stirling, Brayton engines, Photovoltaic, p-n junction, solar cells, PV systems, Stand-alone, Grid connected solar power satellite.

UNIT-III

Wind energy conversion, General formula -Lift and Drag- Basis of wind energy conversion - Effect of density, frequency variances, angle of attack, and wind speed. Windmill rotors-Horizontal axis and vertical axis rotors. Determination of torque coefficient, Induction type generators- working principle.

UNIT-IV

Nature of Geothermal sources, Definition and classification of resources, Utilization for electric generation and direct heating, Well Head power generating units, Basic features-Atmospheric exhaust and condensing, exhaust types of conventional steam turbines. Pyrolysis of Biomass to produce solid, liquid and gaseous fuels, Biomass gasification, Constructional details of gasifier, usage of biogas for chulhas, various types of chulhas for rural energy needs.

UNIT-V

Wave, Tidal and OTEC energy- Difference between tidal and wave power generation, Principles of tidal and wave power generation, OTEC power plants, Operational of small cycle experimental facility, Design of 5 Mw OTEC pro-commercial plant, Economics of OTEC, Environmental impacts of OTEC. Status of multiple product OTEC systems

Suggested Reading:

1. Ashok V Desai, "Non-Conventional Energy", Wiley Eastern Ltd, New Delhi, 2003
2. Mittal K M, "Non-Conventional Energy Systems" Wheeler Publishing Co. Ltd, NewDelhi,2003.
3. Ramesh R & Kumar K U, "Renewable Energy Technologies", Narosa Publishing House,New Delhi, 2004
4. Wakil MM, "Power Plant Technology", Mc Graw Hill Book Co, New Delhi, 2004.

Course Code	Course Title						Core / Elective
OE701CE	GREEN BUILDING TECHNOLOGIES						OE-II
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives:

- Learn the principles of green building technologies and rating systems
- Understand the principles of effective energy and resources management in buildings
- Understand the methodologies to reduce, recycle and reuse towards sustainability.

Course Outcomes:

1. After completing this course, the student will be able to
2. Classify the various features, benefits, and rating systems for a green building
3. Outline the criteria used for site selection and water efficiency methods
4. Select the energy efficiency techniques in designing a green building
5. Select materials for sustainable built environment & adopt waste management methods
6. Identify an appropriate method for maintaining indoor environmental quality in a green building

UNIT-I

Introduction to Green Buildings: Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.

UNIT- II

Site selection and planning: Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect.

Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

UNIT-III

Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy.

Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

UNIT-IV

Building materials: Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials (c) use of materials with recycled content such as blended cements materials from agro and industrial waste. (d) reuse of waste and salvaged materials

Waste Management: Handling of construction waste materials, separation of household waste, on-site and off-site organic waste management

UNIT-V

Indoor Environmental Quality for Occupant Comfort and Well being: Day lighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics.

Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

Suggested Readings:

1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment
3. 'Alternative building materials and technologies' by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. 'Non-Conventional Energy Resources' by G. D. Rai, Khanna Publishers.
5. Sustainable Building Design Manual, Vol.1 and 2, TERI, New Delhi 2004

Course Code	Course Title						Core / Elective
OE 701 CS	**Data Science and Data Analytics**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To learn basics of Data Science: Linear Algebra, Linear Equations, Matrices, Eigen Values and Eigen Vectors.
- To learn various statistical concepts like linear and logistic regression, cluster analysis, time series forecasting
- To learn Decision tree induction, association rule mining and text mining

Course Outcomes:

1. At the end of the course, the students will be able to
2. Use various Mathematical models, and Probability and Statics
3. Uselinear,non-linearregressionmodels,andclassificationtechniquesfordataanalysis
4. Use clustering methods including K-means and CURE algorithm

UNIT – I

Data Science: Introduction to data science, Linear Algebra for data science, Linear equations, Distance, Hyper planes, Half spaces, Eigen values, Eigenvectors.

UNIT II

Statistical Modelling, Random variables, Probability mass/density functions, sample statistics, hypothesis testing.

UNIT III

Predictive Modelling: Linear Regression, Simple Linear Regression model building, Multiple Linear Regression, Logistic regression

UNIT IV

Decision Tree: Introduction, What Is A Decision Tree? Appropriate Problems For Decision Tree Learning, Basic Decision Tree Learning Algorithm, Measuring Features, Hypothesis Space Search In Decision Tree Learning, Inductive Bias In Decision Tree Learning, Why Prefer Short Hypotheses, Issues In Decision Tree Learning.

Classification: K-Nearest neighbors (KNN), Performance Measures,

UNIT V

Clustering: K-Means Algorithm,

Association Rules: Introduction, Frequent Itemset, Data Structure Overview, Mining Algorithm Interfaces, Auxiliary Functions, Sampling from Transaction, Generating Synthetic Transaction Data, Additional Measures of Interestingness, Distance Based Clustering Transaction and Association.

Suggested Readings:

1. Nina Zumel, Practical Data Science with R, Manning Publications,2014.
2. Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, O'Reilly,2017.
3. Hadley Wickham and Garrett Grolemund, R for Data Science, O'Reilly,2017.
4. Roger D Peng, R Programming for Data science, Lean Publishing,2016.
5. Rafael A Irizarry, Introduction to Data Science, LeanPublishing,2016.
6. Vishwa Vishwanathan and Shanthi Vishwanathan, R Data Analysis cookbook 2015

Course Code	Course Title						Core / Elective
OE701EC	Fundamentals of IoT						Open Elective-II
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives:

- Discuss fundamentals of IoT and its applications and requisite infrastructure
- Describe Internet principles and communication technologies relevant to IoT
- Discuss hardware and software aspects of designing an IoT system
- Describe concepts of cloud computing and Data Analytics
- Discuss business models and manufacturing strategies of IoT products

Course Outcomes:

1. After completing this course, the student will be able to
2. Understand the various applications of IoT and other enabling technologies.
3. Comprehend various protocols and communication technologies used in IoT
4. Design simple IoT systems with requisite hardware and C programming software
5. Understand the relevance of cloud computing and data analytics to IoT
6. Comprehend the business model of IoT from developing a prototype to launching a product.

UNIT – I

Introduction to Internet of Things: Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics (Ref 1)

IoT Applications: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and smart Health (Ref1)

UNIT – II

Internet Principles and communication technology: Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source. Prototyping Embedded Devices - Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling (Ref 2)

UNIT – III

API Development and Embedded programming: Getting started with API, writing a new API, Real time Reactions, Other Protocols, Techniques for writing embedded code: Memory management, Performance and Battery Life, Libraries, Debugging. (Ref 2)

Developing Internet of Things: IoT design Methodology, Case study on IoT System for weather monitoring (Ref 1)

UNIT – IV

IoT Systems - Logical Design using Python: Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations., Classes, Python packages for IoT (Ref 1 and Ref 3)

IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

UNIT – V

Cloud computing and Data analytics and IoT Product Manufacturing: Introduction to Cloud storage models and Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT (Ref 1). Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation. (Ref 1) Business model for IoT product manufacturing, IoT Start-ups, Mass manufacturing, Ethical issues in IoT. (Ref 2)

Suggested Readings:

1. Internet of Things (A Hands-On-Approach), Vijay Madisetti, ArshdeepBahga, VPT Publisher, 1st Edition, 2014.
2. Designing the Internet of Things, Adrian McEwen (Author), Hakim Cassimally. Wiley India Publishers.
3. Fundamentals of Python, Kenneth A Lambert and B.L. Juneja, Cengage Learning
4. Internet of Things - Converging Technologies for smart environments and Integrated ecosystems, River Publishers.
5. Internet of things -A hands on Approach, Arshdeep Bahga, Universities press.

Course Code	Course Title						Core/Elective
OE701EE	**Non-Conventional Energy Sources (Open Elective)**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand basics and types of Non-conventional energy sources.
- To understand the working and operation of Solar and wind energy systems.
- To understand the working and operation of Ocean, Geo-thermal and biomass energy systems.

Course Outcomes

At the end of the course students will be able to

- Understand the applications of non-conventional energy sources and fuel cells.
- Acquire the knowledge of Solar energy storage systems, wind generation and control.
- Acquire the knowledge of Geothermal, Biomass and ocean energy conversion systems.

UNIT-I

Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems - Ion exchange membrane cell - Molten carbonate cells - Solid oxide electrolyte cells- Regenerative system- Regenerative Fuel Cell- Advantages and disadvantages of Fuel Cells- Polarization - Conversion efficiency and Applications of Fuel Cells.

UNIT-II

Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

UNIT-III

Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations - Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects.

UNIT-IV

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-thermal Energy - Types of Geo- thermal Energy Systems - Applications of Geo-thermal Energy.

UNIT-V

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation - Thermal gasification of biomass - Biomass gasifies

Suggested Readings:

1. Rai G.D, Non-Conventional Sources of Energy, Khandala Publishers, New Delhi, 1999.
2. M.M.El-Wakil, Power Plant Technology. McGraw Hill, 1984.

Course Code	Course Title						Core/Elective
OE 701 IT	**CYBER SECURITY**						Open Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	**30**	**70**	**3**

Course Objectives:

Students should be able to understand

- The difference between threat and attacks, how threats materialize into attacks.
- Security in Operating Systems & Networks.
- Security Countermeasures
- Privacy in Cyberspace.
- Security Planning, Risk Analysis, Cyber Warfare, Cyberspace and Law

Course Outcomes:

Student will be able to

1. Acquire adequate knowledge about threat and attacks
2. Enhance their skills to implement security in design of Operating Systems
3. Use various techniques of Security Countermeasures
4. Acquire understanding in Privacy Principles and Policies in Cyberspace
5. Enhance their understanding in Security Planning, Risk Analysis, Cyber Warfare, Cyberspace and Law

UNIT I

Introduction To Cyber Security

Introduction -Computer Security - Threats -Harm - Vulnerabilities - Controls - Authentication - Access Control and Cryptography - Web–User Side - Browser Attacks - Web Attacks Targeting Users - Obtaining User or Website Data - Email Attacks

UNIT II

Security In Operating System & Networks

Security in Operating Systems - Security in the Design of Operating Systems -Rootkit - Network security attack- Threats to Network Communications - Wireless Network Security - Denial of Service - Distributed Denial-of-Service.

UNIT III

Defences: Security Countermeasures

Cryptography in Network Security - Firewalls - Intrusion Detection and Prevention Systems - Network Management - Databases - Security Requirements of Databases - Reliability and Integrity - Database Disclosure - Data Mining and Big Data.

UNIT IV

Privacy In Cyberspace

Privacy Concepts -Privacy Principles and Policies -Authentication and Privacy - Data Mining -Privacy on the Web - Email Security - Privacy Impacts of Emerging Technologies - Where the Field Is Headed.

UNIT V

Management And Incidents

Security Planning - Business Continuity Planning - Handling Incidents - Risk Analysis - Dealing with Disaster - Emerging Technologies - The Internet of Things - Economics - Electronic Voting - Cyber Warfare- Cyberspace and the Law - International Laws - Cyber crime - Cyber

Warfare and Home Land Security.

Suggested for Readings

1. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition , Pearson Education , 2015
2. George K.Kostopoulous, Cyber Space and Cyber Security, CRC Press, 2013.

Course Code	Course Title						Core/Elective
OE 701 ME	**START- UP ENTREPRENEURSHIP**						Open Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	**30**	**70**	**3**

Course Objectives:

Students should be able to understand

- To motivate students to take up entrepreneurship in future.
- To learn nuances of starting an enterprise & project management.
- To understand the design principles of solar energy systems, their utilization and performance evaluation.
- To understand the behavioural aspects of entrepreneurs and time management

Course Outcomes:

Student will be able to

- Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
- Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
- Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
- Understand the concept of Intellectual Property Rights and Patents
- Comprehend the aspects of Start-Ups.

Unit-I

Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.

Unit-II:

Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.

Unit-III

Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.

Unit-IV

Intellectual Property Rights: Meaning, Nature, Classification and protection of Intellectual Property, the main forms of Intellectual Property, Concept of Patent, Patent document, Invention protection, Granting of patent, Rights of a patent, Licensing, Transfer of technology.

Unit-V

Aspects of Start-Up: What is Start-Up, Start-up Policy, start-up strategy, Progress of startups in India, Principles of future organizations, start-up sectors, action plan for start-ups by Govt. of India.

Suggested Reading:

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management",* Himalaya Publishing House,1997.
2. Prasanna Chandra, *"Project-Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, *"First Things First",* Simon and Schuster Publication, 1994.

4. G.S. Sudha, *"Organizational Behaviour",*1996.
5. Robert D. Hisrich, Michael P. Peters, *"Entrepreneurship",* Tata Me Graw Hill Publishing Company Ltd., 5lh Ed.,2005.
6. G.B.Reddy,IntellectualPropertyRightsandtheLaw5thEd.2005GogiaLawAgency
7. Ajit Parulekar and Sarita D'Souza, Indian Patents Law–Legal & Business Implications,Macmillan India Ltd, 2006.

Course Code	Course Title						Core/Elective
OE 701 AE	**AUTOMOTIVE MAINTENANCE**						Open Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	**30**	**70**	**3**

Course Objectives:

Students should be able to understand

- To study basic types of vehicle maintenance along with its importance
- To understand the trouble diagnosis procedure for electrical and electronic systems in
- automobiles
- To acquaint with various Trouble shooting, fault tracing practices available in
- automobile industry
- To understand the maintenance procedure for air-conditioning in automobiles.

Course Outcomes:

Student will be able to

1. Demonstrate the maintenance procedure for automotive Engine.
2. Illustrate the trouble diagnosis procedure for electrical systems like Battery, Starting
3. Systems
4. Identify the trouble diagnosis procedure for steering and suspension system
5. Illustrate trouble diagnosis procedure for lubrication and fuel delivery system etc.
6. Explain trouble diagnosis procedure for heating system of automobile.

UNIT – I

Maintenance, Workshop Practices, Safety and Tools: Maintenance – Need, importance, primary and secondary functions, policies - classification of maintenance work - vehicle insurance - basic problem diagnosis.

vehicles, fire safety - First aid. Basic tools -Scheduled maintenance services – service intervals -Towing and recovering.

UNIT – II

Engine and Engine Subsystem Maintenance: introduction engine IC Engine General Engine service- cooling and lubricating system, fuel system, Intake and Exhaust system, electrical system - Electronic fuel injection and engine management. **S**ervice - fault diagnosis- servicing emission controls.

UNIT – III

Transmission and Driveline Maintenance: Clutch- general checks, adjustment and service- road testing, Rear axle service points- removing axle shaft and bearings- servicing differential

assemblies- fault diagnosis.

UNIT – IV

Steering, Brake, Suspension and Wheel Maintenance: *Inspection*, Maintenance and Service of Hydraulic brake, Drum brake, Disc brake, Parking brake. Bleeding of brakes. Inspection, Maintenance and Service of Mc person strut, coil spring, leaf spring, shock absorbers. Wheel alignment and balance, removing and fitting of tyres, tyre wear and tyre rotation. Inspection, Maintenance and Service of steering linkage.

UNIT – V

***Auto Electrical and Air Conditioning Maintenance*:** Maintenance of batteries, starting system, charging system and body electrical -Fault diagnosis using Scan tools. Maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator - Vehicle body repairlike panel beating, tinkering, soldering, polishing, painting.

Suggested Readings:

1. Ed May, "*Automotive Mechanics Volume* , McGraw Hill Publications, 2003.
2. Ed May, "*Automotive Mechanics Volume Two*‖, McGraw Hill Publications, 2003
3. *Vehicle Service Manuals of reputed manufacturers*
4. *Bosch Automotive Handbook*, Sixth Edition, 2004

Code: PW702PE

PROJECT-I
(Project Work-I)
Credits: 3

Instruction: 6 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: 70 marks*

Objectives:

1. To enhance practical and professional skills.
2. To familiarize tools and techniques of systematic literature survey and documentation
3. To expose the students to industry practices and team work.
4. To encourage students to work with innovative and entrepreneurial ideas

Outcomes:

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

- Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
- Grouping of students (max 3 in a group)
- Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.

Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

Each group will be required to:

1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 30 minutes' presentation followed by 10 minutes' discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:

- Problem definition and specification
- Literature survey
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of bar (activity) charts
- Presentation- oral and written.