SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Mechanical Engineering) VII – SEMESTER
(wef: 2021-2022)

S. No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/W	CIE	SEE	Duration in Hours	
Theory Course:										
1	PC701ME	Operations Research	3	-	-	3	30	70	3	3
2	PC702ME	Refrigeration & Air Conditioning	3	-	-	3	30	70	3	3
3	PE-III	Professional Elective-III	3	-	-	3	30	70	3	3
4	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	PE711ME	Industrial Engineering
2	PE712ME	ControlSystems Theory
3	PE713ME	Electric and Hybrid vehicles Technology

Professional Elective-IV		
S. No.	*Course Code*	*Course Title*
1	PE721ME	Additive Manufacturing Technology
2	PE722ME	Robotics Engineering

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)

MC: Mandatory Course
CIE: Continuous Internal Evaluation
SEE: SemesterEndExamination(Univ.Exam)
BS: Basic Science
L: Lecture
P: Practical
ES: Engineering Science
T: Tutorial
D: Drawing

Note:

1. Eachcontacthourisaclockhour

2. Thedurationofthepracticalclassistwohours,howeveritcanbeextendedwherevernecessary, toenablethestudenttocompletetheexperiment.

Code:PC701ME

OPERATIONS RESEARCH
(Professional Core Course)
Credits:3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Course Objectives:

1. To use variables for formulating complex mathematical models in managementscience, industrial engineering and transportation models.
2. Tousethebasicmethodologyforthesolutionoflinearprogrammingproblems.
3. To understand the mathematical tools that are needed to solve optimizationproblems like Transportation models and Assignment models.
4. Tounderstandthereplacementmodelswithchangeinmoneyvalueconsidering withtimeandwithouttime.
5. To Model measuresasystemasaqueuingmodelandcomputeimportantperformance .

Course Outcomes:

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

1. Topreparethestudentstohavetheknowledgeof LinearProgrammingProbleminoperationsResearchattheendstudentswouldbeabletounderstandtheconcept anddevelopthemodelsfordifferentapplications.
2. Tomakestudentsunderstandtheconcept Replacementmodelsattheendstudentswouldabletoexplain variousfeaturesandapplicationsofreplacementmodelsin real timescenario.
3. Topreparethestudentstounderstandtheory of Gameinoperationsresearchatthe endstudentswouldabletoexplainapplicationofGametheoryindecisionmakingfor a conflict.
4. Topreparethestudentstohavetheknowledgeof Sequencingmodelattheend studentwouldabletodevelopoptimummodelforjobscheduling.
5. To prepare students to understand Queuing theory concepts and various optimizationtechniquesattheendstudentswouldabletodevelopmodelsforwaiting line cases.

Unit-I

Introduction: Definition and Scope of Operations Research.

LinearProgramming: Introduction,Formulationoflinearprogrammingproblems,graphical methodofsolvingLPproblem,simplexmethod,maximizationandminimization,Degeneracy inLPP,Unboundedand,Infeasiblesolutions.

Unit-II:

Duality: Definition, Relationship between primal and dual solutions,Economic Interpretation,Postoptimalofsensitivityanalysis,DualSimplexMethod.

Unit-III

TransportationModels: Findinganinitialfeasiblesolution-NorthWestcornermethod, leastcostmethod,Vogel'sApproximationmethod,Findingtheoptimalsolution,optimal solutionbysteppingstoneandMODImethods,SpecialcasesinTransportationproblems- Unbalanced Transportation problem.

Assignment Problems: Hungarian method of Assignment problem, Maximization in Assignmentproblem,unbalancedproblem,problemswithrestrictions,travellingsalesman problems.

Unit-IV

ReplacementModels: Introduction,replacementofitemsthatdeteriorateignoringchange inmoneyvalue,replacementofitemsthatdeterioratecons ideringchangeinmoneyvalue withtime,replacementofitemsthatfailsuddenly-Individualreplacementpolicy,Group

replacementpolicy.
GameTheory:Introduction,2personzerosumgames,Maximin-Minimaxprinciple, PrincipleofDominance,Solutionformixedstrategyproblems,Graphicalmethodfor2xn andmx2games.

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
QueuingTheory:Introduction,singlechannel-Poissonarrivals-exponentialservicetimes withinfinitepopulation&finitepopulation,Multichannel-poisonarrivals-Exponential servicetimeswithinfinitepopulation.
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 ofIndia Pvt. Ltd., 1997.
2. S.D. Sharma, "*Operations Research*", Kedarnath, Ramnath & Co., Meerut, 2009.
3. HrveyM.Wagner,"*PrinciplesofOperationsResearch*",SecondEdition,PrenticeHallofIndia Ltd., 1980.
4. V.K. Kapoor, "*Operations Research*", S. Chand Publishers, New Delhi, 2004.
5. R.PaneerSelvam,"*Operations Research*",SecondEdition,PHILearningPvt.Ltd.,New Delhi, 2008.
6. Data Reconciliation by Prof. Shanker Narasimha.

Code: PC702ME

REFRIGERATION & AIR CONDITIONING
(Professional Core Course)
Credits :3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Course Objectives:

1. To understand the basic concepts of refrigeration and air conditioning systems.
2. Tostudythemethodsofrefrigerationforcommercialandindustrialapplications.
3. Tostudythelowertemperatureapplications:cryogenicsbyusingcascadesystems.
4. Solving the problems related to cooling and heating system (HVAC).

Course Outcomes:

1. Identifyvariousnaturalandartificialmethodsofrefrigeration.Statetheimportanceof refrigerantselectionandtheenvironmentalissuesrelatedtotheuseofCFCs
2. Formulate equations for different types of refrigerants used in vapour compression refrigeration system. Justify the selection of single or multi stage system based onoperating temperature range
3. Explain the working principles of vapour absorption, thermoelectric and steam-jet refrigeration systems. Select a suitable refrigerant absorbent mixture for Vapourabsorption refrigeration system
4. Define Psychrometry and its properties. Analyze various problems on psychrometricprocesses, know the construction and application of Psychrometric chart
5. Abletodesignanaircondoningsystembasedongiveninsideandoutsideconditions. Evaluatecoolingandheatingloadsinanair-conditioningsystem
6. List typical conditions required for various food product processes and List applications of refrigeration and air conditioning

Unit-I

Introduction to Refrigeration: Definition of Refrigeration and Air-conditioning, Necessity of Refrigeration, Methods of Refrigeration, Unit of Refrigeration and C.O.P. Reversed Carnot cycle.

Properties of Refrigerants: Survey, Designation, Desirable properties of refrigerants, Thermodynamic,ChemicalandPhysicalproperties,ClassificationofRefrigerants,Ozone depletion&Globalwarming,GreenHouseEffectandFutureofRefrigerants.

Air Refrigeration Systems: Analysis of Bell-Coleman Cycle, Open and Dense airsystem, Application to aircraft refrigeration, Simple cooling system and Bootstraprefrigeration system,RegenerativecoolingsystemandReducedambientcoolingsystem.

Unit-II:

Vapourcompressionsystem:Workingprincipleandessentialcomponentsof Simplevapor compressionRefrigerationcycle,Compressor,condenser,evaporator,andexpansiondevices, Analysisofcycle,C.O.P,RepresentationofthecycleonT-S,P-HandH-Scharts.Performance improvementofsimplevapourcompressionrefrigerationcyclebymeansofflashchamber andaccumulatorDryandwetcompression,Effectofoperatingconditionslikeevaporating pressure, condenser pressure, Liquid sub-cooling and Vapor super heating, Performance of thesystem.Lowtemperaturerefrigerationsystem(withsingleloadsystem),Compound compressionwithwaterintercoolerandFlashintercooler,Cascaderefrigerationsystem-Analysis and advantages

Unit-III

Vapour Absorption Refrigeration System: Simple absorption systems, COP, Practical ammonia absorption refrigeration system, Lithium bromide absorption system, Electrolux refrigerator, Common refrigerants and absorbents properties, Comparison with vapor compression refrigeration system
SteamJetRefrigeration:Principleofworking,Analysisofthesystem,Advantages,limitations andapplications.
Non-Conventional Refrigeration Systems: Principle and operation of Thermoelectric Refrigeration Systems, Seebeck effect - Peltier effect - Thomson effect, Analysis, Pulse tube refrigeration system.

Unit-IV

Psychrometry:Psychrometricproperties,Psychrometricchart,construction,Representation ofPsychrometricprocessesonthechart.
Introduction to Air Conditioning: Requirements of comfort air conditioning, Thermodynamics of human body, Body temperature, Metabolism, Body defense and Human tolerance, Effect of heat on performance, ASHRE comfort chart and Effective temperature.

Unit-V

CoolingLoadCalculationsinAirConditioning:Conceptofbypassfactor,Sensibleheatfactor, ApparatusDewPoint,RoomSensibleHeatFactor(RSHF),GrossSensibleHeatFactor(GSHF), Differentheatingandcoolingloads,Problems.
Designofairconditioningsystems:Allfreshair,Re-circulatedairwithbypassedair,Designof Summer,winterandYearroundairconditioningsystems,Energyconservationinair conditionedbuilding,Casestudyofonebuildingwithallloadcalculations.
AirConditioningSystems:Types,Componentsofairconditionerequipments,Humidifier, Dehumidifier,Filter,Grills,FansandBlowers,Ductmaterial,FunctionofDampers,Diffusers.
ApplicationsofRefrigerationandAirconditioningFoodPreservation,Transportair conditioning,andIndustrialapplications.

Suggested Reading:

1. AroraC.P.,"RefrigerationandAirconditioning",TataMcGrawHill,NewDelhi,2009.
2. Arora,S.C.andDomkundwar,S.,"ACourseinRefrigeration and Air conditioning",DhanpatRai&Sons,NewDelhi,2010.
3. Jain,V.K.,"RefrigerationandAirConditioning",SChand&Company,NewDelhi,2010.
4. Stocker,W.S.,"RefrigerationandAirconditioning",McGrawHill,NewDelhi,2009.
5. RKRajput.,"Refrigeration&Airconditioning",SKKataria&SonsNewDelhi,Third Edition2015.

Code: PE711ME

INDUSTRIAL ENGINEERING
(Professional Elective-III)
Credits:3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Course Objectives:

1. TolearntheconceptofManagement.
2. TounderstandroleofProductionPlanningandControlinIndustry.
3. Tolearnvariousmaterialprocurementpolicies.
4. Tounderstandimportanceofqualitycontrolandvariousmethods.
5. TointerprettheroleofDecisiontheoryinIndustry.

Course Outcomes:

After completing this course, the student will be able to

1. Explainvariousapproachesforindustrialmanagement.Abletoinferconceptof managementinhumanresourcedomain
2. ApplyPhilosophyofProductionPlanningandControlinIndustryandcontrolthe activities in delivering the products in time
3. Determinetheoptimumrequirementofinventorybydevelopingthevarious quantitativemodels.
4. Developvariousmodelsormethodsforensuringtherequiredqualityoftheproducts orprocesses.
5. ElaboratetheroleofDecisiontheoryandapplyvariousapproachesunder UncertaintyandRiskconditions

Unit-I

Management: Introduction to Management, Scientific Management, Systems approach to Management, MBO, and Decision Making Process.
Personnel Management: Functions of personnel management, types of training, Job evaluation and Merit rating, Collective bargaining and labour participation in management.

Unit-II:
ProductionPlanning&Control: Definition,Objectives,ImportanceandFunctionsof ProductionPlanning&Control.
ProductionControl: Routing,Scheduling,Dispatching,Follow-upandprogressReport.

Unit-III

Inventory Control: Importance of inventory control, types of inventory models Inventorycostsdeterministicinventorymodels BasicEOQmodels,productionmodel without shortages, Purchase model with instantaneous replenishment and with shortages production model with shortages Inventory model with pricebreaks,Fixedorderqualitysystem,periodicreviewsystemInventorymodelwithproba bilisticdemand.

Unit-IV

QualityControl:Conceptofquality,evolutionofqualitycontrol,assignableandchance causesofvariation,VariableControlcharts(XandRcharts)
Attributes control charts: P chart and C chart
AcceptanceSampling–SingleSampling,DoubleSamplingandMultisamplingplans – OC curves of single

Unit-V

DecisionTheory:Introduction,Decision,DecisionMaking&DecisionTheory,Types ofDecisions,decisionmakingprocess,TypesofDecisionmakingEnvironment:

Decision making under Uncertainty- Criterion of Optimism or Maximax, Criterion of Pessimism or Maximin, Minimax decision criteria
Decision making under Risk: Expected Monetary Value(EMV), Expected Opportunity Loss (EOL) Criterion & Expected Value of Perfect Information(EVPI) Criterion, Decision Trees.

Suggested Reading:

1. M.Mahajan,"IndustrialEngineeringandProductionManagement",Dhanpatrai& sons, New Delhi
2. S.K.SharmaandSavitasarma,"IndustrialEngineeringandOrganization Management",SKKataria&Sons,NewDelhi.
3. S.D. Sharma, "Operations Research", Kedarnnath, Ramnath& Co., Meerut, 2009
4. S Kalavathi, "Operations Research", Vikas Publishing House Pvt. Ltd, 2009
5. V. K. Kapoor, "Operations Research", S. Chand, New Delhi.
6. SKSharma&SavitaSharma,"AcourseinIndustrialEngineering&Operations Management",SKKataria&Sons,2008

Code:
PE712ME

CONTROL SYSTEMS THEORY
(Professional Elective-III)

Credits :3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Course Objectives:

1. Toknowthedevelopmentofinput-outputrelationsusingblockdiagrams,signalflow graphsofmechanical,electromechanicalsystemsetcandmethodsofobtainingtime and frequency response.
2. Tounderstandthestabilityandmarginsforstabilityfromcharacteristicsequation,root-locus method or frequency methods.
3. Toknowthedevelopmentofthealternativestatespacemodelsofdynamicsystems, andtheirimportanceinpredictingtimeresponseofmultiplevariablesofthesystem.

Course Outcomes

1. Derivethetransferfunctionofmechanical,electrical,hydraulicandthermalsystems.
2. Evaluate the time response of I and II order systems for various input signals.
3. SketchtheBode,PolarandRootlocusplotstocheckthestabilityofthesystem.
4. Sketch the Nyquist plot and design the Lead & Lag compensators to meet therequirements.
5. DeveloptheStatespacemodelofasystem,checkforitsControllability&Observability.

Unit-I

ControlSystemsClassification:OpenLoop&ClosedLoopSystems.Mathematicalmodelsand Transferfunctionsfromgoverningequationsofmechanical,electrical,hydraulic,pneumatic, thermalsystemsAC,DCservomotors&Electromechanicalservosystems

Unit-II:

BlockDiagrams-Blockdiagramreduction.Signalflowgraphs,Mason'sgainformula.Transient responseTimedomainspecificationsof1stand2ndordersystemsSteadystateerror,Error coefficients,andsensitivityPerformanceindicesRouthcriteria

Unit-III

Routhcriteria-RootLocusmethodFrequencyResponse:Bode,Polarplots.Correlation betweentransientandfrequencyresponse,Bandwidth,Experimentaldeterminationof transferfunctions

Unit-IV

Nyquistcriteria-Gainandphasemargins,Lead.LagandLead-lagcompensatordesign,PID controller,linearizationofNonlinearsystems.

Unit-V

State-SpaceRepresentationofLinearControlSystems:Statetransitionmatrix.Solutionof stateequations:ZeroinputresponseandZerostateresponse.Conceptofcontrollabilityand observability

Suggested Reading:

1. Dorf, R.C., *Modern Control Systems, Addison*-Wesley1989.
2. M. Gopal, *Con tori Systems,* Tata McGraw Hill,2004.
3. Ogata, K., *Modern Control Engineering,* Prentice Hall,2004.
4. NormanS.Nise,*ControlSystemsEngineering*,JohnWiley&Sons,Inc.,2001.

Code: PE713ME

ELECTRIC AND HYBRID VEHICLE TECHNOLOGY
(Professional Elective-III)

Credits :3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Course objectives:

- To Understand Electric vehicle technology
- To Understand electric vehicle Energy Storage systems
- To know Electric propulsion systems
- To know the classification drives in hybrid vehicles their principles and merits
- To understand Drive Structures forelectric vehicle technology

Course Outcomes:

The student is able to

1. Understand Electric vehicle technology.
2. Know-how of power plants used in Electric vehicles and their significance
3. Understand Electric propulsion systems
4. To provide exposure to Electric vehicle battery technology and control systems.
5. Able to classify drives in hybrid vehicles their principles and merits

UNIT - I

INTRODUCTION: Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy suppliesElectric vehicles; configuration of EVs, performance, traction motor characteristics, tractive effort and transmission requirements.

UNIT- II

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT - III

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives

UNIT - IV

Hybrid Drives: Introduction, features, functional classification, start/stop system, mild hybrid, full hybrid, plug-in-hybrid, batteries for hybrid vehicles, and optimization of hybrid configurations. Changing modes for conductive charging.

UNIT - V

Hybrid Electric Vehicles (HEVS) And Drive Structures: Concept of electric drive train, architecture of hybrid electric drive train, series hybrid drive, parallel hybrid electrical drive train.

Electric and Hybrid Vehicles - Case Studies: Honda Insight, Chevrolet Volt, GM EV1, Toyota RAV 4 EV and Ford; Think City

Suggested Reading

1. Iqbal Husain, "Electic and Hybrid vehicles Design Fundamentals" , CRC Press, second Edition 2013
2. James Larminie, John Lowry, "Electric vehicle techonology Explained" 2nd Ed.,Wiley 2012
3. Vehicular Electrical Power Systems – Emadi, Ehasni, Mercel (Marcel Dekker)
4. Electric and Hybrid vehicles – Pistoia (Elsevier)
5. Fuel cells principles and applications - B.Vishwanath, M. Aulice Scibion (University Press)
6. Electrical vehicle machine and drives – K.T.Chau (Wiley).

Code:PE721ME

ADDITIVE MANUFACTURING TECHNOLOGY
(Professional Elective-IV)
Credits:3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

CourseObjectives:

1. Tounderstandthefundamentalconceptsofadditivemanufacturing,itsadvantagesand limitations.
2. Toknowtheworkingprinciple,advantages,disadvantagesandapplicationsofliquid,solid and Powder based Technologies.
3. ToknowthevarioustypesofSTLfileerrorsandotherdataformatsusedinadditive manufacturingTechnology.
4. To know the features of various softwares used in additive manufacturing.
5. To know diversified applications of additive manufacturing Technologies.

Course Outcomes:

On successful completion of this course, the student will be able to

1. Interpret the features of additive manufacturing and compare it with conventional methods.
2. Illustratetheworking principleofliquid, solidandpowder based additive manufacturing Technologies. Additive manufacturing
3. IdentifyvarioustypesoferrorsinSTLfileandotherdataformatsused additive manufacturingTechnology.
4. Select suitable software used in additive manufacturing Technology.
5. Apply the knowledge of various additivemanufacturingtechnologies for developing innovative applications.

Unit-I

Introduction: Prototyping fundamentals: Need for time compression in product development, Historical development, Fundamentals of Rapid Prototyping, rapid prototypingprocesschain,AdvantagesandLimitationsofrapidprototyping,rapid prototyping wheel, Commonly used Terms, Classification of processes.

Unit-II:

Liquid-basedSystems:StereoLithographyApparatus(SLA):Modelsandspecifications, Process,workingprinciple,photopolymers,photopolymerization,Layeringtechnology, laserandlaserscanning,Applications,AdvantagesandDisadvantages,Casestudies.Polyjet: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Casestudies

Solid-based System: Laminated Object Manufacturing (LOM): Models and specifications, Process,workingprinciple,Applications,AdvantagesandDisadvantages,Casestudies. Fused Deposition Modeling (FDM): Models and specifications, Process, workingprinciple, Applications, Advantages and Disadvantages, Case studies.

Unit-III

Powder Based Systems: Working principle, Specifications, Materials used, Process, Applications,AdvantagesandDisadvantages,CasestudiesofthefollowingTechnologieslike Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct MetalLaser

Sintering(DMLS),LaserEngineeredNetShaping(LENS),ElectronBeamMelting(EBM).

Unit-IV

DataFormats&Software:STLFormat,STLFileProblems,ConsequenceofBuildingValid andInvalidTessellatedModels,STLfileRepairs,NewlyProposedFormats. Software'sFeatures:Magics,Mimics,SolidView,ViewExpert,3DRhino,3Ddoctor,Flash Print,ObjectStudio,Cura,ITKSnap,3-matic,Simplant,3-matic,Simplant,MeshLab,Ansys for Additive Manufacturing

Unit-V

ApplicationsofAdditiveManufacturing:ApplicationinDesign,ApplicationinEngineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, JewelleryIndustry,CoinIndustry,GISapplication,ArtsandArchitecture.RPMedicaland BioengineeringApplications:Planningandsimulationofcomplexsurgery,Customized Implants&Prosthesis,DesignandProductionofMedicalDevices,ForensicScienceand Anthropology,VisualizationofBiomolecules.Biopolymers,Packaging,Disaster Management, Entertainment and Sports industry.

Suggested Reading:

1.CheeKaiChuaandKahFaiLeong,"*3D Printingand AdditiveManufacturingPrinciples and Applications*"FifthEdition,Worldscientific

2.IanGibson,DavidWRosen,BrentStucker,"*AdditiveManufacturingTechnologies:3D Printing, Rapid Prototyping, and Direct Digital Manufacturing*" Springer,SecondEdition,2010.

3. "*Rapid Prototyping & Engineering Applications*"- Frank W.Liou, CRC Press, Taylor &Francis Group,2011.

4.RafiqNoorani,"*RapidPrototyping:PrinciplesandApplicationsinManufacturing*",John Wiley &Sons,2006.

5. NPTEL Course on Rapid Manufacturing.https://nptel.ac.in/courses/112/104/112104265/

Code: PE722ME

ROBOTIC ENGINEERING
(Professional Elective-IV)
Credits:3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

CourseObjectives: Students will understand

1.Theconfiguration,workenvelopandmotioncontrolsandapplications
2. Familiarities with the kinematics ofrobots.
3. Robot end effectors and theirdesign.
4. Familiarities with the dynamics ofrobots.
5.Robot Programming methods & Languages ofrobot.
6. Various Sensors and drives and their applications inrobots

CourseOutcomes:

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 theirDegrees 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. Identifysuitability of various control methods.
5. Interface various hardware and software components to develop robotic systems forindustry&Evaluatetheirperformance.

Unit-I

BriefHistory,Typesofrobots,Overviewofrobotsubsystems,RobotJointsanditsLinks, Degreesoffreedomofrobots,WorkspaceofRobots,accuracy,precision,resolutionand repeatability,Robotclassification:Basedonkinematicconfigurations,controlmethods, workspace.DifferenttypesofWristsusedinindustrialrobots.DifferenttypesofRobot Drives.EndeffectorsandGrippers,Mechanical,Electrical,vacuumandothermethodsof gripping.
Robots used in various Industrial operations like Material handling,Assembly, Inspection,WeldingandPainting.DescriptionandSpecificationsineachcase.

Unit-II:

Rotationmatrices,Representationoflocationandorientation.EulerangleandRPY representation, Homogeneous transformation matrices Denavit-Hartenbergnotation,
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 Configurationofrobots,StaticforceanalysisofRPtypeandRRtypeplanarrobots, DynamicanalysisusingLagrangianandNewton-EulerformulationsofRRandRPtype planar robots.

Unit-IV

Trajectory Planning: Joint interpolation, task space interpolation, executing user specified tasks, Independent joint control, PD and PID feedback, actuator models, nonlinearityofmanipulatormodels,Computedtorquecontrol,forcecontrol,hybrid control,neuralnetworkbasedcontrolofmanipulator,fuzzycontrolofmanipulator,CNN based control of manipulator.

Unit-V

Sensors:typesofsensors,tactile&nontactilesensors,sensorstomeasurePosition, velocity &acceleration , Optical encoders. Range and Proximity sensing, acoustic, pneumatic,Halleffectsensor,Eddycurrentsensors,ForceandTorquesensors.

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.SpongandVidyasagar,"RobotDynamics&Control",JohnWileyandSons,Ed.,1990

2.MittalandNagrath,"IndustrialRobotics",TataMcGrawHillPublications,2004.

3. Saha&Subirkumarsaha, 'Robotics', TMH, India.

4. Asada and Sllotine , 'Robot analysis and intelligence' BS Publications , India.

5.Fu.K.S.,GonZalezR.C.,LeeC.S.G."Robotics,Control-sensingvisionandIntelligence", McGrawHill,Int.Ed.,1987.

6. GrooverM.P.,"Industrial Robotics", McGraw Hill Publications, 1999.

7. Robotics toolbox in MATLAB.

Code: PE723ME

COMPUTATIONAL FLUID DYNAMICS
(Professional Elective-IV)

Credits:3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Course Objectives

1. Toconverttheconservationequationsoffluidflowindifferentialforminto algebraicequationsandapplynumericalmethodstoobtainsolutions
2. To learn the finite difference method.
3. Tolearnfinitevolumemethodandsolutionmethodologyforfluidflowproblems

Course Outcomes

1. Understand the concepts of turbulence and fluid dynamics
2. Determineanddevelopthepartialdifferentialequationsforvariousconditions
3. Design the grid for different applications
4. Determine the finite difference solutions
5. Analyse the systems using finite volume method

UNIT-I

Review of basic equations of fluid dynamics: Continuity, Momentum and Energy equations,NavierStokesequations,ReynoldsandFavreaveragedN–Sequations. Differentialequationsforsteadyandunsteadystateheatconduction.Differential equations for diffusion. Introduction to turbulence, Turbulence models-mixinglength model, K- turbulence Model.

UNIT-II

Classification of PDEs – Elliptic, parabolic and hyperbolic equations. Initial and boundaryvalueproblems.ConceptsofFinitedifferencemethods–forward,backward andcentraldifference.Errors,Consistency,StabilityanalysisbyvonNeumann. Convergence criteria.

UNIT-III

Grid Generation- Types of grid O,H,C. Coordinate transformation, algebraic methods. Unstructured grid generation.

UNIT-IV

FinitedifferenceSolutions-ParabolicPDEs–Euler,CrankNicholson,Implicitmethods, Elliptic PDEs – Jacobi, Gauss Seidel, ADI, methods. FD- solution for Viscous incompressibleflowusingStreamfunction–Vorticitymethod&MACmethod.

UNIT-V

IntroductiontoFinitevolumemethod.Finitevolumeformulationsfordiffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows. Use of Staggered grids SIMPLE Algorithm.

Suggested Reading:

1. PradipNiyogi,ChakrabarttySK,LahaM.K.,„IntroductiontoComputationalFluid Dynamics",PearsonEducation,2005.
2. MuralidharK,SundararajanT,„ComputationalFluidflowandHeattransfer",Narosa Publishing House,2003.
3. Chung,TJ,„ComputationalFluidDynamics",CambridgeUniversityPress,2002.
4. JohnDAnderson,„ComputationalFluidDynamics",McGrawHill,Inc.,1995.
5. Patankar,S.V,„NumericalHeattransferandFluidflow",HemispherePublishing Company,NewYork,1980.

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 energysources.
- To understand the working and operation of Solar and wind energysystems.
- To understand the working and operation of Ocean, Geo-thermal and biomass energysystems.

Course Outcomes

At the end of the course students will be able to

- Understand the applications of non-conventional energy sources and fuelcells.
- Acquire the knowledge of Solar energy storage systems, wind generation andcontrol.
- Acquire the knowledge of Geothermal, Biomass and ocean energy conversionsystems.

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 referencetoH2°2Cell-ClassificationandBlockdiagramoffuelcellsystems-Ionexchangemembrane cell-Moltencarbonatecells-Solidoxideelectrolytecells-Regenerativesystem-RegenerativeFuelCell-Advantages and disadvantages of Fuel Cells- Polarization - Conversion efficiency and Applications of FuelCells.

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

Windenergy-Principlesofwindenergyconversionsystems-Natureofwind-PowerintheWind-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 -Environmentalaspects.

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

conversiondevices-Advantagesanddisadvantagesofwaveenergy-Geo-thermalEnergy-TypesofGeo- thermal Energy Systems - Applications of Geo-thermalEnergy.

UNIT-V

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency-Biogasgeneration-SelectionofsiteforBiogasplant-ClassificationofBiogasplants-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 infuture.
- 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, themain forms of Intellectual Property, Concept of Patent, Patent document, Invention protection, Granting ofpatent,Rightsof apatent, Licensing, Transfer oftechnology.

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. AjitParulekarandSaritaD'Souza,IndianPatentsLaw– Legal&BusinessImplications,MacmillanIndiaLtd,2006.

Course Code	Course Title						Core/Elective
OE 701 AE	**AUTOMOTIVEMAINTENANCE**						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 studybasic types of vehiclemaintenancealong with its importance
- Tounderstandthe troublediagnosis procedurefor electrical andelectronicsystemsin
- automobiles
- ToacquaintwithvariousTroubleshooting,faulttracingpracticesavailable in
- automobileindustry
- Tounderstand themaintenanceprocedurefor air-conditioningin automobiles.

Course Outcomes:

Student will be able to

1. DemonstratethemaintenanceprocedureforautomotiveEngine.
2. Illustratethetroublediagnosisprocedureforelectricalsystemslike Battery,Starting
3. Systems
4. Identifythe troublediagnosis procedureforsteeringand suspensionsystem
5. Illustratetroublediagnosis procedure forlubrication andfuel deliverysystem etc.
6. Explaintroublediagnosisprocedureforheatingsystem ofautomobile.

UNIT – I

Maintenance,WorkshopPractices,SafetyandTools: Maintenance– Need,importance,primary and secondary functions, policies - classification of maintenance work - vehicleinsurance-basic problem diagnosis.

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

UNIT – II

Engine and Engine Subsystem Maintenance: introduction engine IC Engine General Engineservice-

coolingandlubricatingsystem,fuelsystem,IntakeandExhaustsystem,electricalsystem-Electronicfuelinjectionandenginemanagement.**S**ervice-faultdiagnosis-servicingemissioncontrols.

UNIT – III

Transmission and Driveline Maintenance: Clutch- general checks, adjustment and service-roadtesting,Rearaxleservicepoints-removingaxleshaftandbearings-servicingdifferential assemblies-faultdiagnosis.

UNIT– IV

Steering, Brake, Suspension and Wheel Maintenance: *Inspection*, Maintenance and Service ofHydraulicbrake,Drumbrake,Discbrake,Parkingbrake.Bleedingofbrakes.Inspection,MaintenanceandServiceofMcpersonstrut,coilspring,leafspring,shockabsorbers.Wheelalignment and balance, removing and fitting of tyres, tyre wear and tyre rotation. Inspection,Maintenance and Serviceof steeringlinkage.

UNIT – V

***AutoElectricalandAirConditioningMaintenance*:**Maintenanceofbatteries,startingsystem,chargingsystemandbodyelectrical-

FaultdiagnosisusingScantools.Maintenanceofairconditioningpartslike compressor,condenser,expansionvalve,evaporator-Vehiclebodyrepairlikepanel beating, tinkering, soldering, polishing,painting.

SuggestedReadings:

1. EdMay,"*AutomotiveMechanicsVolume*,McGrawHillPublications,2003.
2.EdMay,"*AutomotiveMechanicsVolumeTwo*||,McGrawHillPublications,2003
3.*VehicleServiceManualsof reputedmanufacturers*
4.*BoschAutomotiveHandbook*, Sixth Edition,2004

Code: PW702ME

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

Instruction: 6 periodsperweek *Duration of SEE:--*
CIE: 50marks *SEE: 70marks*

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. Toencouragestudentstoworkwithinnovativeandentrepreneurialideas

Outcomes:

1. Demonstratetheabilitytosynthesizeandapplytheknowledgeandskillsacquiredin the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectivelyplanaprojectandconfidentlyperformallaspectsofprojectmanagement
4. Demonstrate effective written and oral communication skills

Thedepartmentcaninitiatetheprojectallotmentprocedureattheendof VIsemesterand finalizeitinthefirsttwoweeksofVIIsemester.

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

- Collection of project topics/ descriptions from faculty members (Problems can also beinvitedfromtheindustries)
- Groupingofstudents(max3inagroup)
- Allotmentofprojectguides

Theaimofprojectworkistodevelopsolutionstorealisticproblemsapplyingthe knowledgeandskillsobtainedindifferentcourses,newtechnologiesandcurrentindustry practices.Thisrequiresstudentstounderstandcurrentproblemsintheirdomainand methodologiestosolvetheseproblems.Togetawarenessoncurrentproblemsand solutiontechniques,thefirst4weeksofVIIsemesterwillbespentonspeciallectures by facultymembers,researchscholars,postgraduatestudentsofthedepartmentandinvited lecturesbyengineersfromindustriesandR&Dinstitutions.Aftercompletionofthese seminarseachgrouphastoformalizetheprojectproposalbasedontheirownideasoras suggestedbytheprojectguide.

Seminarschedulewillbepreparedbythecoordinatorforallthestudentsfromthe5th weektothelastweekofthesemesterwhichshouldbestrictlyadheredto.

1. Each group will be requiredto:

1. Submitaone-pagesynopsisbeforetheseminarfordisplayonnoticeboard.
2. Givea30minutes'presentationfollowedby10minutes'discussion.
3. Submitatechnicalwrite-uponthetalk.

AtleasttwoteacherswillbeassociatedwiththeProjectSeminartoevaluatestudentsfor theawardofsessionalmarkswhichwillbeonthebasisofperformanceinallthe3items statedabove.

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

- Problemdefinitionandspecification
- Literaturesurvey
- Broadknowledgeofavailabletechniquestosolveaparticularproblem.
- Planningofthework,preparationofbar(activity)charts
- Presentation-oralandwritten.

SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Mechanical Engineering) VIII – SEMESTER
(Proposed for the Academic year 2021-2022)

S. No	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in	
Theory Course										
1	PE-V	Professional Elective-V	3	-	-	3	30	70	3	3
2	PE-VI	Professional Elective-VI	3	-	-	3	30	70	3	3
3	OE-III	Open Elective-III	3	-	-	3	30	70	3	3
Practical / Laboratory Course										
4	PW703ME	Project-II	-	-	16	16	50	150		8
Total										**17**

Professional Elective-V		
S. No.	*Course Code*	*Course Title*
1	PE811ME	Mechanical Vibrations
2	PE812ME	Composite Materials
3	PE813ME	Power Plant Engineering

Professional Elective-VI		
S. No.	*Course Code*	*Course Title*
1	PE821ME	Energy Conservation & Management
2	PE822ME	Non-Destructive Testing
3	PE823ME	Entrepreneurship Development

Open Elective – III		
1	OE801 CE	Road Safety Engineering (Not for Civil Engg. Students)
2	OE801CS	Fundamentals of AI & ML (Not for CSE & IT students)
3	OE801 EE	Smart Building Systems (Not for EEE & EIE Students)
4	OE802 EE	Programmable Logic Controllers (Not for EEE & EIE Students)
5	OE801EC	Principles of Electronic Communications (Not for ECE students)
6	OE801IT	Software Engineering (Not for IT Students)
7	OE801ME	3D Printing Technologies (Not for Mechanical and Production students)
8	OE801AE	Elements of Electrical and Hybrid Vehicle Technology

MC: Mandatory Course
CIE: Continuous Internal Evaluation
SEE: SemesterEndExamination(Univ.Exam)
BS:BasicScience
L: Lecture
P: Practical
ES: Engineering Science
T: Tutorial
D: Drawing

Note:

1. Eachcontacthourisaclockhour
2. Thedurationofthepracticalclassistwohours,howeveritcanbeextendedwherever

necessary,toenablethestudenttocompletetheexperiment.

Code: PE811ME

MECHANICAL VIBRATIONS
(Professional Elective-V)
Credits :3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Objectives:

Student has to understand the

1.Explaintheconceptofvibrations,withsingledegreeoffreedomsystems
2.Discuss the numerical methods involved in vibrations
3.Demonstrate the concept of Transient vibrations

Outcomes:

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

1. FindtheNaturalfrequenciesofSDoFSystems.
2. Drawthemodeshapes.
3. SolvetheMDoFSystems
4. DotheModelanalysis.
5. Applythenumericalmethodstovibration Problems.

Unit-I

FreeVibrationofSingleDegreeofFreedomSystems: Introduction,causesandeffects ofvibration.FreeVibrationofanUndampedTranslationalSystem,EquationofMotion usingNewton'ssecondlawofmotion,Equationofmotionusingothermethods, Equationofmotionofaspring,masssysteminverticalposition,solution,Harmonic MotionFreeVibrationofanUndampedTorsionalSystem-Equationofmotion.Free Vibration with Viscous Damping- Equation of motion.

Unit-II:

Forced Vibration of Single Degree of Freedom Systems: Introduction, Beating Phenomenon.ResponseofaDampedsystemundertheHarmonicMotionofthebase, Force Transmitted, Relative Motion.

Unit-III

Two Degree of Freedom Systems: Introduction, Equations of Motion for forced Vibration, Free Vibration Analysis of and undamped system, Torsionalsystem, CoordinateCouplingandPrincipalCoordinates,forcedVibrationAnalysis,Semidefinite Systems.

Unit-IV

Multi-degreeofFreedomSystems: IntroductionModelingofContinuoussystemsas Multi-degreeofFreedomsystems.Equationsofmotion,InfluenceCoefficients.Potential andkineticenergyexpressionsinmatrixform,Generalizedcoordinatesandgeneralized forces,UsingLagrange'sequationstoderiveequationsofmotion,Equationsofmotionof undampedsystemsinmatrixform,Eigenvalueproblem,solutionoftheEigenvalue problems – solution of the characteristic equation, orthogonality of normal modes.

Unit-V

Determination of Natural Frequencies and Mode Shapes: Introduction,Dunkerley's formula, Rayleigh's Method- Properties of Rayleigh's Quotient, Computation ofthe FundamentalNaturalFrequency,FundamentalFrequencyofBeamsandShafts.Holzer's

Method-Torsional systems, Spring Mass Systems. Jacobi method, Standard Eigen value Problems.

Suggested Reading:

1. W T Thomson., "Theory of Vibrations with Applications", CBS Publishers
2. S S Rao, "Mechanical Vibrations", Addison-Wesley Publishing Co.
3. LeonardMeirovitch,"FundamentalsofVibration",McGrawHillInternationalEdison.
4. J P Den Hartog, "Mechanical Vibrations", McGraw Hill.
5. Srinivasan, "Mechanical Vibration Analysis", McGraw Hill.
6. NunoManuelMendesMaiaetal,"TheoreticalandExperimentalModalAnalysis",Wiley John &sons,1999

Code: PE812ME

COMPOSITE MATERIALS
(Professional Elective-V)
Credits :3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Objectives

Student has to understand the

1. Understandthebasicstructureofcomposites
2. Manufacturingprocessesinvolvedincomposites
3. Higro-thermal stresses incomposites
4. Behavior and design of composites

Outcomes

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

1. Demonstratetheknowledgeofcompositesandtheirstructures
2. Demonstrate the manufacturing processes involved in composites
3. Analyseandpredictthestressandstrainrelationshipincomposites.
4. Summarizeandapplythedesignproceduresandfailurecriteriaof composites
5. Apply the testing procedures of composites

UNIT-I

Introduction: Fibres, Matrixmaterials, interfaces, polymermatrixcomposites, metalmatrix composites, ceramic matrix composite, carbon fibre composites, Applications of composites.

UNIT-II

Fabricationprocesses, openmouldprocesses, handlay-upcomposites, sprayupcomposites, prepeggingprocesses, autoclavemoulding, sheetmouldingcompound(SMS), Resigntransfer moulding, thermo plastic moulding, Filament winding process, pultrusion process.

UNIT-III

Micromechanics of Composites: Mechanical Properties: Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses. Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

UNIT-IV

Macromechanics of Composites: Elastic constants of a lamina relations between engineeringconstantsandreducedstiffnessandcompliances, variationoflaminaproperties withorientation, analysisoflaminatedcomposites, stressesandstrainswithorientation, inter-laminarstressesandedgeeffects, Simplifiedcompositebeamsolutions. Bendingof laminatedbeams.

UNIT-V

Designofcomposites-Maximumstresstheory, maximumstraincriteria, Tsai-hill, Tsai-wu criteria, fracturemodesincomposites.

Testingofcomposites-Measurementofconstituentmaterialproperties-fibretestandresign matrixtest.Measurementofbasiccompositeproperties–Tensiletest,compressivetest,in-planesheartest,interlaminarsheartest,flexuraltest

Suggested Readings:

1. Jones,R.M.,'MechanicsofCompositeMaterials',Mc-GrawHillCo.,1967.
2. Calcote,L.R.,'TheAnalysisofLaminatedCompositeStructures',VanNostrand,1969.
3. Whitney.I.M., Daniel, R.B.Pipes, 'Experimental Mechanics of fibre Reinforced CompositeMaterials',PrenticeHall,1984.
4. Hyer.M.W.,'StressAnalysisofFibre-ReinforcedCompositeMaterials',McGrawHillCo., 1998.
5. Carl.T.Herakovich,'MechanicsofFibrousComposites',JohnWileySonsInc.,1998.

Code: PE813ME

POWER PLANT ENGINEERING
(Professional Elective-V)
Credits :3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Objectives:

Student has to understand the

1.Operation of steam turbine and gas turbine power plants
2.About hydraulic power plant, hydrology, dams and spillways
3. Various types of nuclear power plants including Pressurized water reactor, Boiling water reactor, Liquid metal fast breeder reactor and Gas cooled reactor
4. The power plant economics
5.The environmental and safety aspects of power plant operation.

Outcomes:

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

1. Selectcoalandashhandlingmethodsforacoalfiredpowerplant.
2. Comprehendbasicworkingprincipleofsteamandgasturbinepowerplant
3. ClassifyDamsandSpillways.
4. Demonstrate the basic principles of thermal-fission and fast-breeder nuclear powerplants,suchaspressurized-water,boiling-water,andheavy-waterreactors.
5. Analyzeloadfactor,capacityfactor,averageloadandpeakloadonapowerplant.
6. Illustratethecontrolmethodsofmajorpollutantsemittedfromfossil-fuelpower plants.

Unit-I

Introduction to Sources of Energy-Resources and Development of Power in India. Steam***PowerPlant:***Plantlayout,workingofdifferentCircuits,Fuelandhandling equipment,typesofcoal,coalhandling,choiceofhandlingequipment,coalstorage,ash handlingsystems.

Unit-II:

CombustionProcess:Propertiesofcoal-overfeedandunderfeedfuelbeds,traveling gratestokers,spreaderstokers,retortstokers,pulverizedfuelburningsystemandits components, combustion needs and draught system, cyclone furnace, design and construction,Dustcollectors,coolingtowers,andheatrejection,corrosionandfeed watertreatment.
Gas Turbine Power Plant: Introduction -Classification-Layout with Auxiliaries-Principles of working of closed and open cycle gas turbines

Unit-III

HydroElectricPowerPlant:WaterPower-Hydrologicalcycle,flowmeasurement-drainageareaCharacteristics-Hydrographs-storageandpondage-classificationof damsandspillways

Unit-IV

NuclearPowerStation:Nuclearfuel-breedingandfertilematerials-Nuclearreactor- reactor Operation- Pressurized water reactor, boiling water reactor, sodium-graphite reactor,fastbreederreactor,homogeneousreactor,gas-cooledreactor.
Radiation hazards and shielding -radioactive waste disposal.

Unit-V

Power Plant Economics and Environmental Considerations: Capital cost,investment offixedcharges,operatingcosts,generalarrangementofpowerdistribution,Load curves,averageloadandloadfactor,deliveryfactor-relatedexercisesEffluentsfrom powerplantsandimpactonenvironment-PollutantsandPollutionStandards-Methods of pollution control

Suggested Reading:

1.Rajput,RK,*ATextBookof'PowerPlantEngineering*,3rdEdition.LaxmiPublications,New Delhi.

2.AroraSC,DomukundwarS,*ACourseinPowerPlantEngineering,*DhanpatRai&Sons,New Delhi.

3. Yadav R, *Steam & Gas Turbines and Power Plant Engineering,* 7th Edition, Central Publishing House, Allahabad,2007.

4.NagPK,*PowerPlantEngineering,*2ndEdition,TataMcGrawHillsCo.Ltd,New Delhi,2002.

5. WakilMM,*Power Plant Technology*,MeGrawHillPublications,Newyork,2005.

Code: PE821ME

ENERGY CONSERVATION AND MANAGEMENT
(Professional Elective-VI)

Credits :3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Objectives:

1. Tolearnaboutenergyconservation.
2. Tounderstandsourcesoflossofpowerinenergyconversion.
3. TounderstandProcedureforComprehensiveEnergyConservationPlanning.
4. TounderstandIndustrialenergyconservationmethods.

Outcomes:

On successful completion of this course, the student will be able to

1. Understanddifferentformsofenergy.
2. Calculatetheamountofheatenergyavailable.
3. Understandtheindustryenergyconservationmodeling.
4. Understandmethodologyforforecastingindustrialenergysupplyanddemand.

Unit-I

Definition, Principles of Energy Conservation - Maximum Thermodynamic efficiency. MaximumCost-effectivenessinenergyuse.Variousformsofenergy-HeatMechanical. ElectricalenergyandChemicalenergy.Identificationofpotentialsourcesofenergylosses-Transportation, operation and conversion from one from to another.

Unit-II:

Heatenergyandstorage-Mediaoftransportofheatenergy-steam,oilandfluegases. Calculationofsteamquality.Calculationofamountofheatenergyavailable.Recuperators. Constructionaldetails,Selectionofmaterialstostoreheatenergy.Conceptofpower. Modesofmechanicalenergytransport-Gears,pulleys,belts,shaftsetc.,Calculationof power.Sourcesoflossofpowerinenergyconversionintoelectricity,potentialenergy(i.e., pumps).

Unit-III

Chemicalenergy-combustionoffuels-petrol,dieselandcoal.Lossduetoqualityoffuel, conversionintootherformofenergy-boilers,I.C.engines.Calculationrelatedtolosses. Electricalenergy-Workingprincipleofmotorsandgenerators.Calculationofefficiencyof generators. Losses during transmission and energy conversion - into mechanical energy, thermalenergy.Calculationofeffectingparameters.

Unit-IV

Procedure for Comprehensive Energy Conservation Planning (CECP) -Specifying targets, identifying energy in-efficient facilities. Synthesize evaluation and optimization of alternative conservation measures in view of organization costs. Flow chart of organization's functions. Collection of accountable data. Application of CECP method. An example.

Unit-V

Industrialenergyconservationmodeling-Methodology-Definitionofproductionsystem-Aprimarycopperproductionsystem,Modelconstruction-MathematicalProgramming.

Market penetration, Structure of energy conservation model. Data preparation - coefficientsneededinamodel,Unitproductioncostandunitenergyrequirements.Model exercise,verificationandvalidation.MethodologyforforecastingIndustrialEnergySupply andDemand.

Suggested Reading:

1. GottschalkC.M.,"*Industrial Energy Conservation*",JohnWiley&Sons,1996.
2. ChaturvediP.,andJoshiS.,"*StrategyforEnergyConservationinIndia*",Concept PublishingCo., NewDelhi,1997.
3. Sharna and VenkataSebhaiah, "Energy *management and conservation*".
4. Dr. Sanjeevsingh, UmeshRathore, "*Energy management*", Edition 2019.
5. Mrs.PNagaveni,Dr.AAmudha,Dr.M.SivaramkumarandMr.N.Prasanna,"*Energy management and Energyconservation*".

Code: PE822ME

NON-DESTRUCTIVE TESTING
(Professional Elective-VI)

Credits :3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Objectives:

Student has to understand the

1. Need, basic concepts and technologies of Non-Destructive Testing(NDT)
2. Security precautions from Radiography, protection from radiation and measurement of radiation received by personnel.
3. Technologyofacousticemission(AE),theassociatedinstrumentationandapplications
4. Technologies like neutron radiography; laser induced ultrasonics, surface analysis and thermography
5. Merits and demerits of the different NDT Technologies
6. Latest research and developments in NDT

Outcomes:

1. The knowledge of different NDT techniques.
2. Clear understanding of liquid penetrate inspection and magnetic particle inspection.
3. The basics of Eddy Current Testing.
4. View and interpret radiographs, utilize the various principles of radiography for different components of different shapes
5. TheknowledgeofacousticemissionforNDTandtheinstrumentationusedforNDT
6. The knowledge of latest research, developments and trends in NDT

Unit-I

Liquid Penetrate inspection: Principle of penetrate inspection, characteristics of a penetrate, water washable system, post emulsification system, solvent removable system, surface preparation and cleaning, penetrate application, development, advantages, limitations, andapplications.

Magnetic Particle Inspection: Principle, magnetization methods, continuous and residual methods, sensitivities, demagnetization, Advantages, Limitations, and Applications.

Unit-II:

EddyCurrentTesting:Principle,lift-offfactor,andedgeeffect,skineffect,inspection frequency,coilarrangements,inspectionprobes,typesofcircuits,referencepieces,phase analysis,displaymethodsandapplications

Unit-III

UltrasonicTesting:Generationofultrasound,Characteristicsofanultrasonicbeam, sound waves at interfaces, sound attenuation, display systems, probe construction,type of display, inspection techniques, identification of defects, immersion testing, sensitivity and calibration. Reference standards, surface conditions, applications

Unit-IV

Radiography:Principleandusesofradiography,limitationprinciple,radiationsources, production of X-rays, X-ray spectra, attenuation of radiation, shadow formation enlargement and distortion, radiographic film and paper, inspection of simple and complexshapes,radiationhazard,protectionagainstradiation.

Unit-V

Acoustic Emission: physical principles, sources of emission, instrumentation and applications.

OtherNDTTechniques:Neuronradiography,laserinducedultrasonics,surfaceanalysis, andthermography.

Suggested Reading:

1. Barry Hull & Vernon John, '*Non-Destructive Testing*' , 1988.
2. Non-Destructive examination and quality control, ASM International, Vol.17, 9th edition 1989
3. J. Prasad and C.G.K. Nair, Non-Destructive Test and evaluation of materials, Tata McGraw-Hill Education, 2nd edition 2011
4. B.Raj,T.JayakumarandM.Thavasimuth,PracticalNon-DestructiveTesting,Alpha Science International Limited, 3rd edition 2002
5. T.Rangachari,J.PrasadandB.N.S.Murthy,TreatiseonNon-DestructiveTestingand Evaluation,Navbharathenterprises,Vol.3,1983.

Code: PE823ME

ENTREPRENEURSHIP DEVELOPMENT
(Professional Elective-VI)

Credits :3

Instruction: 3 periodsperweek *Duration of SEE: 3hours*
CIE:30marks *SEE: 70marks*

Objectives:

1. Tomotivatestudentstotakeupentrepreneurshipinfuture.
2. Tolearnnuancesofstartinganenterprise&projectmanagement.
3. Tounderstandthedesignprinciplesofsolarenergysystems,theirutilizationand performanceevaluation.
4. Tounderstandthebehavioralaspectsofentrepreneursandtimemanagement.

Outcomes:

1. UnderstandIndianIndustrialEnvironment,EntrepreneurshipandEconomic growth,SmallandLargeScaleIndustries,Typesandformsofenterprises.
2. Identifythecharacteristicsofentrepreneurs,Emergenceoffirstgeneration entrepreneurs,Conceptionandevaluationofideasandtheirsources.
3. Practicetheprinciplesofprojectformulation,Analysisofmarketdemand,Financialandpr ofitabilityanalysisandTechnicalanalysis.
4. ApplytheconceptsofProjectManagementduringconstructionphase,projectorganizatio n,projectplanningandcontrolusingCPM,PERTtechniques.
5. Understandthebehaviouralaspectsofentrepreneurs,TimeManagement,Various approachesoftimemanagement,theirstrengthsandweakness.Theurgency addictionandtimemanagementmatrix.

Unit-I

Indian Industrial Environment-competence, Opportunities and Challenges. EntrepreneurshipandEconomicgrowth.SmallScaleIndustryinIndia,Objectives,Linkage amongsmall,mediumandheavyindustries.Typesofenterprises.

Unit-II:

Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluationofideasandtheirsources.ChoiceofTechnology-Collaborativeinteractionfor Technologydevelopment.

Unit-III

Projectformulation,Analysisofmarketdemand,Financialandprofitabilityanalysisand Technicalanalysis,projectfinancinginIndia.

Unit-IV

ProjectManagementduringconstructionphase,projectorganization,projectplanningand controlusingCPM,PERTtechniques.Humanaspectsofprojectmanagement.Assessment of taxburden.

Unit-V

Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time Management: Various approaches of time management, their strengths

and weaknesses. The urgency addiction and time management matrix.

Suggested Reading:

1. VasantDesai,"*DynamicsofEntrepreneurialDevelopmentandManagement*",Himalaya Publishing House,1997.
2. Prasanna Chandra, "*Project-Planning, Analysis, Selection, Implementation and Review*", Tata McGraw-Hill Publishing Company Ltd. 1995.
3. StephenR.CoveyandA.RogerMerrill,"*FirstThingsFirst*",SimonandSchuster 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.

CourseCode	CourseTitle						Core/Elective
OE801 CE	*ROADSAFETYENGINEERING*						**Open Elective-III**
Prerequisite	ContactHoursper Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

CourseObjectives:

- Introductiontovariousfactorsconsideredforroadsafetyandmanagement
- Explainthe roadsafetyappurtenancesanddesignelements
- Discussthevarious trafficmanagementtechniques

CourseOutcomes:

Aftercompletingthis course,the studentwillbe ableto

1. Understandthe fundamentalsoftraffic safetyanalysis
2. AnalyzeAccidentdata
3. Rememberthe conceptsofroad safetyin urban transport
4. Applycrashreduction techniques
5. DesignofurbanInfrastructureconsideringsafetyaspects.

UNIT – I

Introduction:

RoadSafetyscenarioinIndiaandWorld,RoadAccidentCharacteristics.

Traffic Safety Analysis: Fundamentals of Traffic Engineering **-** Basic Characteristics of Motor-Vehicle Traffic,Highway Capacity, Applications of Traffic ControlDevices, Design of Parking Facilities, Traffic EngineeringStudies;StatisticalMethodsinTrafficSafetyAnalysis– RegressionMethods,PoissonDistribution,Chi-Squared Distribution,StatisticalComparisons.

UNIT – II

Accident Analysis: Accident Investigations and Risk Management, Collection and Analysis of Accident Data,Condition and Collision Diagram, Causes and Remedies, Traffic Management Measures and Their Influence onAccident Prevention, Assessment of Road Safety, Methods to Identify and Prioritize Hazardous Locations andElements,DeterminePossibleCausesofCrashes,CrashReduction CapabilitiesandCountermeasures,Effectiveness ofSafetyDesignFeatures,AccidentReconstruction. Applicationofcomputeranalysisofaccidentdata.

UNIT – III

RoadSafetyinplanningandGeometricDesign:VehicleAndHumanCharacteristics,RoadDesignandRoadEquipment‘s,RedesigningJunctions,CrossSection Improvements,ReconstructionandRehabilitationofRoads, RoadMaintenance,TrafficControl,VehicleDesignandProtectiveDevices,PostAccidentCare.

UNIT – IV

***TrafficSignals&Roadsigns*:**TrafficSignals,Factorsaffectingsignaldesign,stre etlighting,ProvisionsforNMTVehiclesinIndia, SafetyProvisionsfor Pedestrians&Cyclists, Road SignsandPavementMarkings.

SafetyatConstructionSite: Safetyprovisionsfor workersatconstructionsite,ConstructionZone markings,signs.

UNIT – V

TrafficManagementsafetyaudit:TrafficManagementSystemsforSafety,Roa dSafetyAuditsandToolsforSafetyManagementSystems, RoadSafety Audit Process,ApproachtoSafety,RoadSafetyImprovementStrategies,ITSandSafety.

SuggestedReadings:

1. Kadiyali L.R,. *TrafficEngineeringandTransportplanning*,9thEdition,KhannaTech Publishers,2013.
2. C.E.G.Justo, A. VeeraragavanandS. K.Khanna,*HighwayEngineering*,10th Edition, NemChandPublishers,2017.
3. DonaldDrew,*TrafficFlow TheoryChapter 14 inDifferential EquationModels*, Springer, 1983
4. C. Jotinkhisty and B. Kent Lall, *Transportation Engineering – An Introduction, 3rd Edition,Pearsonpublications, 2017*
5. RuneElvik, AlenaHoye,TrulsVaa,Michael Sorenson,*Handbookof RoadSafety measures,secondEdition,EmeraldPublishing,2009.*
6. HighwayResearch Programme(NCHRP) Synthesis336.*A synthesisofHighwayResearch Board, WashingtonD.C,2016*.

CourseCode	CourseTitle						Core/Elective
OE801CS	*FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING*						**Open Elective-III**
Prerequisite	ContactHoursper Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

CourseObjectives:

- Cover various paradigms that come under the broad umbrella of AI.
- To understand various key paradigms for machine learning approaches
- To familiarize with the mathematical and statistical techniques used in machine learning.
- To understand and differentiate among various machine learning techniques

CourseOutcomes:

Aftercompletingthis course,the studentwillbe ableto

1. Develop an understanding of modern concepts in AI and where they can be used
2. Design, implement and apply novel AI techniques based on emerging real-world requirements
3. To formulate a machine learning problem
4. Select an appropriate pattern analysis tool for analyzing data in a given feature space.
5. Apply pattern recognition and machine learning techniques such as classification and feature selection to practical applications and detect patterns in the data.
6. Design and program efficient algorithms related to recent machine learning techniques, train models, conduct experiments, and develop real-world ML-based applications and products

UNIT-I:

INTRODUCTION: Definitions of Artificial Intelligence, Artificial Intelligence Problems, Topics of Artificial Intelligence, Timelines of Artificial Intelligence, Production Systems, State Space Representation, Branches of Artificial Intelligence, Applications of Artificial Intelligence,

UNIT-II:

HEURISTIC SEARCH TECHNIQUES: Generate-and-Test , Hill Climbing, Search Techniques, Problem Reduction, Constraints Satisfaction, Means-ends Analysis

KNOWLEDGE REPRESENTATION: Knowledge Management, Types of Knowledge, Knowledge Representation, Approaches to Knowledge Representation, Issues in Knowledge Representation, Knowledge Base

UNIT-III:

LEARNING: Types of Learning, Machine Learning, Intelligent Agents

CLUSTERING: k-Means Clustering, Fuzzy Clustering, Hierarchical Clustering, Cluster Similarity, Case Studies,

UNIT-IV:

STATISTICAL LEARNING: Hidden Markov Models, Linear Classifiers, Quadratic Classifiers, Decision Trees, Bayesian Networks, Case Studies,

ARTIFICIAL NEURAL NETS: ANN Basics, ANN—Learning Process, Types of Networks, Perceptron, RBF Networks, ANN Summary, Case Studies

UNIT-V:

SUPERVISED LEARNING: Support Vector Machines, Inductive Logic Programming, Case-based Reasoning, Ensemble Classifiers, Nearest Neighbourhood, Fuzzy Network, Case Studies,

UNSUPERVISED LEARNING: Expectation Maximization, Self organizing maps, Adaptive resonance theory, Case studies

Suggested Readings:

1. Vinod Chandra S.S and AnandHareendran S , “Artificila Intelligence and Machine Learning ”, PHI , 2014
2. PrashantKikani, “Demystifying Artificial intelligence: Simplified AI and Machine Learning concepts for Everyone”, January 2021, BPB publication
3. Dr. Nilakshi Jain , “Artificial Intelligence, As per AICTE: Making a System Intelligent” January 2019, WILEY India
4. LavikaGoel , “Artificial Intelligence: Concepts and Applications” January 2021, WILEY India

Course Code	Course Title						Core / Elective
OE801EE	**SMART BUILDING SYSTEMS**						**OE -III**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
	3	**-**		**-**	**30**	**70**	**3**

Course Objectives:

- To understand the basic blocks of Building Management System.
- To design various sub systems (or modular system) of building automation
- To integrate all the sub systems

Course Outcomes:

Student will be able to

- Describe the basic blocks and systems for building automation
- Use different subsystems for building automation and integrate them
- Understand basic blocks and systems for building automation
- Design different systems for building automation and integrate those systems

UNIT – I

Introduction: Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.

UNIT – II

Fire Alarm (FA) System: concept of fire, Fire modes, History, Components, and Principles of Operation. Different fire sensors, smoke detectors and their types, Fire control panels, design considerations for the FA system. Field Components, Panel Components, Applications. Types of FAS Architectures, Examples. Classification of FAS loops, Examples. FAS Design procedure in brief, NFPA 72A, BS 5839, IS, Concept of IP enabled fire & alarm system, design aspects and components of PA system.

UNIT – III

Access Control System: Access Components, Access control system Design.

CCTV: Camera Operation & types, Camera Selection Criteria, Camera Applications, DVR Based system, DVM, Network design, Storage design. Components of CCTV system like cameras, types of lenses, typical types of cables, controlling system. CCTV Applications.

UNIT – IV

Security Systems Fundamentals: Introduction to Security Systems, Concepts.

Perimeter Intrusion: Concept, Components, Technology, Advanced Applications. Security system design for verticals. concept of automation in access control system for safety, Physical security system with components, RFID enabled access control with components, Computer system access control –DAC, MAC, RBAC.

EPBX System & BMS subsystem integration: Design consideration of EPBX system and its components, integration of all the above systems to design BMS.

UNIT – V

Energy Management: Energy Savings concept & methods, Lighting control, Building Efficiency improvement, Green Building (LEED) Concept & Examples.

Building Management System: IBMS (HVAC, Fire &Securi-ty) project cycle, Project steps BMS, Advantages & Applications of BMS, IBMS Architecture, Normal & Emergency operation, Advantages of BMS.

Suggested Readings:

1. Jim Sinopoli, *Smart Buildings,* Butterworth-Heinemann imprint of Elsevier,2nd ed., 2010.
2. Reinhold A. Carlson, Robert A. Di Giandomenico, *Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs),* R.S. Means Company Publishing, 1991.
3. Albert Ting-Pat So, WaiLok Chan, Kluwer, *Intelligent Building Systems,* Academic publisher,3rd ed., 2012.
4. Robert Gagnon, *Design of Special Hazards and Fire Alarm Systems*, Thomson Delmar Learning; 2nd edition, 2007.
5. Levenhagen, John I.Spethmann, Donald H, *HVAC Controls and Systems*, McGraw-Hill Pub.
6. Hordeski, Michael F, *HVAC Control in the New Millennium*, Fairmont press, 2001.
7. Bela G. Liptak, *Process Control-Instrument Engineers Handbook*, Chilton book co.

Course Code	CourseTitle						Core/Elective
OE 802EE	**PROGRAMMABLELOGICCONTROLLERS**						**Open Elective-III**
Prerequisite	ContactHoursperWeek				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

CourseObjectives

- TobeabletounderstandbasicsofProgrammablelogiccontrollers,basicprogrammingofPLC.
- TomakethestudentstounderstandtheFunctionsandapplicationsofPLC

CourseOutcomes

At theendofthe coursestudentswill beableto

1. DevelopPLCprogramsforindustrial applications.
2. AcquiretheknowledgeofPLCcounterfunctionsandPLCArithmeticfunctionsanddatahandlingfunctions.

UNIT-I

PLC Basics: Definition and History of PLC - PLC advantages and disadvantages - Over all PLC Systems - CPUsand Programmer Monitors - PLC input and output models - Printing PLC Information- Programming Procedures -Programming Equipment - Programming Formats- Proper Construction of PLC Diagrams - Devices to which PLCinput and output modules are connected - Input on/off switching devices - Input analog devices - Output analogon/offdevicesand outputanalogdevices.

UNIT-II

Basic PLC Programming: Programming on/off inputs to produce on/off outputs - PLC input instructions -Outputs - Operational procedures - Contact and coil input/output programming examples - Relation of digital gatelogic contact / coil logic - PLC programming and conversion examples - Creating ladder diagrams from processcontroldescriptions- Sequencelistings-Large process ladderdiagramconstructions.

UNIT-III

Basic PLC Functions: General Characteristics of Registers - Module addressing - Holding registers - Inputregisters - output registers - PLC timer functions - examples of timer functions. Industrial applications - PLCcounterfunctions.

UNIT-IV

Intermediate Functions: PLC Arithmetic functions - PLC additions and subtractions - The PLC repetitive clock -PLC Multiplications, Division and Square Root - PLC trigonometric and log functions - Other PLC arithmeticfunctions - PLC number comparison functions. PLC basic

comparison functions and applications - Numberingsystems and number conversion functions - PLC conversion between decimal and BCD-Hexadecimals numberingsystems.

UNIT-V

Data Handling Functions: The PLC skip and master control relay functions - Jump functions - Jump with nonreturn - Jump with return. PLC data move Systems - The PLC functions and applications. PLC functions workingwithbits-PLCdigital bitfunctionsand applications-PLCsequencefunctions-PLCmatrix functions.

SuggestedReading:

1. John W. Weff, Ronald A. Reis, Programmable Logic Controllers, Prentice Hall of India Private Limited, Fifthedition,2003.
2. FrankD.Petruzella,*Programmable LogicControllers*,5th Edition,Mc-GrawHill,2019.

Course Code	Course Title						Core / Elective
OE 801 EC	**PRINCIPLES OF ELECTRONIC COMMUNICATIONS**						**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	**Credits**
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Provide an introduction to fundamental concepts in the understanding of communicationssystems.
- Provide an introduction to network model and some of the network layers including physical layer, data link layer, network layer and transportlayer.
- Provide an introduction to the evolution of wireless systems and current wirelesstechnologies.

Course Outcomes

1. Understand the working of analog and digital communicationsystems
2. Understand the OSI network model and the working of datatransmission
3. Understand the evolution of communication technologies from traditional telephony systems to modern wireless communicationsystems.

UNIT – I

Introduction to communication systems: Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels.

Signal Transmission Concepts: Baseband transmission and Broadband transmission,

Communication Parameters: Transmitted power, Channel bandwidth and Noise, Need for modulation **Signal Radiation and Propagation:** Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation.

UNIT – II

Analog and Digital Communications: Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation.

UNIT – III

Data Communication and Networking: Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP.

UNIT – IV

Telecommunication Systems: Telephones, Telephone system, Paging systems, Internet Telephony.

Optical Communications: Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

UNIT – V

Wireless Communications: Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks.

Suggested Readings:

1. *Principles of Electronic Communication Systems*, Louis E. Frenzel, 3e, McGraw Hill,2008.
2. *Data Communications and Networking,* Behrouz A. Forouzan, 5e TMH,2012.
3. Kennady, Davis, *Electronic Communications systems*, 4e, McGraw Hill,1999.

CourseCode	CourseTitle						Core/Elective
OE 801 IT	*SOFTWAREENGINEERING*						**Open Elective-III**
Prerequisite	ContactHoursper Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

CourseObjectives:

- Tointroducethebasicconceptsofsoftwaredevelopmentprocessesfromdefiningaproductto shippingandmaintaining.
- Toimpartknowledgeonvariousphases,methodologiesandpracticesofsoftwaredevelopment.
- Tounderstandtheimportanceoftestinginsoftwaredevelopment,studyvarioustestingstrategiesalongwithitsrelationshipwithsoftware qualityandmetrics.

CourseOutcomes:

Aftercompletingthis course,the studentwillbe ableto

1. Acquired working knowledge of alternative approaches and techniques for each phase ofsoftwaredevelopment
2. Judgeanappropriateprocessmodel(s)assessingsoftwareprojectattributesandanalyze necessaryrequirements forproject developmenteventuallycomposingSRS.
3. Creationofvisualmodelstodescribe(non-)algorithmicsolutionsforprojectsusing variousdesignprinciples.
4. Acquireskillsnecessaryasanindependentoraspart ofateamfor architectinga completesoftwareprojectbyidentifyingsolutionsforrecurringproblems exertingknowledgeon patterns.

UNIT – I

IntroductiontoSoftwareEngineering:

A generic view of Process: Software Engineering, Process Framework, CMM Process Patterns,ProcessAssessment.

ProcessModels:PrescriptiveModels,WaterfallModel,IncrementalProcessModels,Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal andTeamProcess Models, Process Technology, Product andProcess.

AnAgileviewofProcess:IntroductiontoAgilityandAgileProcess,AgileProcessModels

UNIT – II

SoftwareEngineeringPrinciples:SEPrinciples,CommunicationPrinciples,PlanningPrinciples,ModelingPrinciples, Construction Principles, Deployment.

System Engineering: Computer-based Systems, The System Engineering Hierarchy, BusinessProcessEngineering, Product Engineering,

SystemModeling.

Requirements Engineering: A Bridge to Design and Construction, Requirements EngineeringTasks, Initiating Requirements Engineering Process, Eliciting Requirements, Developing Use-Cases, BuildingtheAnalysisModel, NegotiatingRequirements,ValidatingRequirements.

UNIT – III

Building the Analysis Model: Requirements Analysis Modeling Approaches, Data ModelingConcepts, Object-Oriented Analysis, Scenario-based Modeling, Flow-oriented Modeling, Class-basedModeling, CreatingaBehavioral Model.

Design Engineering: Design within the context of SE, Design Process and Design Quality,DesignConcepts, TheDesign Model,Pattern-based Software Design.

UNIT– IV

Creating an Architectural Design: Software Architecture, Data Design, Architectural Styles andPatterns,Architectural Design.***ModelingComponent-LevelDesign:***DefinitionofComponent,DesigningClass-basedComponents,ConductingComponent-levelDesign,ObjectConstraintLanguage,DesigningConventionalComponents. ***PerformingUserInterfaceDesign:***TheGoldenRules,UserInterfaceAnalysisand Design,InterfaceAnalysis, InterfaceDesignSteps,Design Evaluation.

UNIT – V

Testing: Strategies: A Strategic Approach to Conventional Software Testing, Test Strategies forO-OSoftware.

Tactics: Software Testing Fundamentals, Black-box and White-box Testing, Basis Path Testing,ControlStructureTesting, O-O TestingMethods.

Debugging:DebuggingTechniques,TheArtof Debugging.

ProductMetrics:AFrameworkforProductMetrics,Metricsforeachphaseofsoftwaredevelopment.

SoftwareQuality:Definition,***QualityAssurance:***BasicElements,FormalApproaches,Statistical Software Quality Assurance, Software Reliability, ISO9000 Quality Standards, SQAPlan.

SuggestedReadings:

1. RogerS.Pressman,*SoftwareEngineering:APractitioner'sApproach*,7th Edition,McGraw Hill, 2009
2. AliBehforoozandFrederickJ.Hudson,*SoftwareEngineeringFundamentals*,Oxford UniversityPress, 1996
3. PankajJalote,*AnIntegratedApproachtoSoftwareEngineering*,3rd Edition,NarosaPublishingHouse, 2008

CourseCode	CourseTitle						Core/Elective
OE 801 ME	*3DPRINTING TECHNOLOGIES*						**Open Elective-III**
Prerequisite	ContactHoursper Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

CourseObjectives:

- Tounderstandthefundamentalconceptsof3DPrinting,itsadvantagesandlimitations.
- Toknowtheworkingprinciple,advantages,disadvantagesandapplicationsofliquid,solidandPowderbased3DPrintingTechnologies.
- Toknowdiversifiedapplicationsof3DPrintingTechnologies.

CourseOutcomes:

Aftercompletingthis course,the studentwillbe ableto

1. Interpretthefeaturesof3DPrintingandcompareitwithconventionalmethods.
2. Illustratetheworkingprincipleofliquid,solidandpowder-based3DPrintingTechnologies.
3. Applytheknowledgeofvarious3DPrintingtechnologiesfordevelopingInnovativeapplications.

Unit-I

Introduction:Prototypingfundamentals,Historicaldevelopment,Fundamentalsof3DPrinting, Advantages and Limitations of 3D Printing, commonly used Terms, 3D PrintingProcess Chain, 3D Modeling, Data conversion and Transmission, Checking and Preparing,Building,Post-processing,RPDataformats,Classificationof3Dprintingprocesses,Fundamental AutomatedProcesses,Distinctionbetween3DPrintingandConventionalMachiningProcesses.

Unit-II

Liquid-basedSystems:StereoLithographyApparatus(SLA):Modelsandspecifications,Process,workingprinciple,photopolymers,photopolymerization,Layeringtechnology,laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Polyjet:Modelsandspecifications,Process,workingprinciple,Applications,AdvantagesandDisadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process,workingprinciple, Applications, AdvantagesandDisadvantages, Casestudies.

Unit-III

Solid-based System: Laminated Object Manufacturing (LOM): Models and specifications,Process,workingprinciple,Applications,AdvantagesandDisadvantages,Casestudies.Fused Deposition Modeling (FDM): Models and specifications, Process, working principle,Applications,AdvantagesandDisadvantages,Casestudies.Multi-JetModelling(MJM):Modelsandspecifications,Process,Workingprinciple,Applications,AdvantagesandDisadvantages, Case studies.

Unit-IV

Powder Based Systems: Selective laser sintering (SLS): Models and specifications, Process,workingprinciple,Applications,AdvantagesandDisadvantages,Casestudies.Three-dimensionalPrinting(3DP):Modelsandspecifications,Process,workingprinciple, Applications, Advantages and Disadvantages, Case studies. Laser Engineered Net Shaping(LENS): Modelsand specifications,Process, working principle,Applications,AdvantagesandDisadvantages,Case studies.

Unit-V

Applications of 3D Printing : Application in Design, Application in Engineering, Analysis andPlanning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewelry Industry,Coin Industry, GIS application, Arts and Architecture, Pattern for investment and vacuumcasting,MedicalModelsandBioengineeringApplications:Planningandsimulationofcomplexsurgery,CustomizedImplants&Prosthesis,DesignandProductionofMedicalDevices,ForensicScienceandAnthropology,andWebBasedRapidPrototypingSystems.

SuggestedReading:

1. Chee Kai Chua and Kah Fai Leong, “3D Printing and Additive Manufacturing PrinciplesandApplications”FifthEdition,Worldscientific
2. Ian Gibson, David W Rosen, Brent Stucker, “Additive Manufacturing Technologies: 3DPrinting, Rapid Prototyping, and Direct Digital Manufacturing” Springer, Second Edition,2010.
3. Frank W.Liou, “Rapid Prototyping & Engineering Applications”- CRC Press, Taylor &FrancisGroup,2011.
4. Rafiq Noorani, “Rapid Prototyping: Principles and Applications in Manufacturing”, JohnWiley& Sons,2006.

CourseCode	CourseTitle						Core/Elective
OE 801 AE	*ELEMENTS OF ELECTRIC AND HYBRID VEHICLE TECHNOLOGY*						**Open Elective-III**
Prerequisite	ContactHoursper Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

CourseObjectives:

- To understand the hybrid vehicle technology
- To know the energy storage requirements and analyze the hybridization of different storage devices.
- To understand the configuration of various electric propulsion units.
- To know the different hybrid drives and the concept of electric drive trains.

CourseOutcomes:

Aftercompletingthis course,the studentwillbe ableto

1. Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
2. Discuss different energy storage technologies used for hybrid electric vehicles and their control.
3. Analyze various electric drives suitable for hybrid electric vehicles.
4. Explain plug – in hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles.
5. Demonstrate different configurations of electric vehicles and its components, hybrid vehicle configuration by different techniques, sizing of components and design optimization and energy management.

Unit - I

Introduction: Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy suppliesElectric vehicles; configuration of EVs, performance, traction motor characteristics, tractive effort and transmission requirements.

Unit- II

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

Unit - III

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives

Unit - IV

Hybrid Drives: Introduction, features, functional classification, start/stop system, mild hybrid, full hybrid, plug-in-hybrid, batteries for hybrid vehicles, and optimization of hybrid configurations. Changing modes for conductive charging.

Unit - V

Hybrid Electric Vehicles (HEVs) And Drive Structures: Concept of electric drive train, architecture of hybrid electric drive train, series hybrid drive, parallel hybrid electrical drive train.

Electric and Hybrid Vehicles - Case Studies: Honda Insight, Chevrolet Volt, GM EV1, Toyota RAV 4 EV and Ford; Think City

Suggested Reading

1. Iqbal Husain, "Electic and Hybrid vehicles Design Fundamentals" , CRC Press, second edition 2013
2. James Larminie, John Lowry, "Electric vehicle techonology Explained" 2nd Ed.,Wiley 2012
3. Vehicular Electrical Power Systems – Emadi, Ehasni, Mercel (Marcel Dekker)
4. Electric and Hybrid vehicles – Pistoia (Elsevier)
5. Fuel cells principles and applications - B.Vishwanath, M. AuliceScibion (University Press)
6. Electrical vehicle machine and drives – K.T.Chau (Wiley).

Code: PW703ME

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

Instruction: 6 periodsperweek *Duration of SEE:--*
CIE: 50marks *SEE: 70marks*

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. Toencouragestudentstoworkwithinnovativeandentrepreneurialideas

Outcomes:

1. Demonstratetheabilitytosynthesizeandapplytheknowledgeandskillsacquired 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

TheaimofProjectwork–IIistoimplementandevaluatetheproposalmadeaspartof ProjectWork-I.Studentscanalsobeencouragedtodofulltimeinternshipaspartof projectwork-IIbasedonthecommonguidelinesforallthedepartments.Thestudents placedininternshipsneedtowritethenewproposalinconsultationwithindustry coordinatorandprojectguidewithintwoweeksfromthecommencementofinstruction.

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

1. Re-groupingofstudents-deletionofinternshipcandidatesfromgroups madeaspartofprojectWork-I
2. Re-Allotmentofinternshipstudentstoprojectguides
3. Projectmonitoringatregularintervals

Allre-grouping/re-allotmenthastobecompletedbythe1st weekofVIIIsemestersothat studentsgetsufficienttimeforcompletionoftheproject.

Allprojects(internshipanddepartmental)willbemonitoredatleasttwiceinasemester throughstudentpresentationfortheawardofsessionalmarks.Sessionalmarksare awardedbyamonitoringcommitteecomprisingoffacultymembersaswellasbythe supervisor.Thefirstreviewofprojectsfor25markscanbeconductedaftercompletion offiveweeks.Thesecondreviewforanother25markscanbeconductedafter12weeks ofinstruction.

Commonnormswillbeestablishedforthefinaldocumentationoftheprojectreportby therespectivedepartments.Thestudentsarerequiredtosubmitdraftcopiesoftheir projectreportwithinoneweekaftercompletionofinstruction.

Note: Three periods of contact load will be assigned to each project guid