			L	**T**	**P**	**Cr.**
B.Tech (VIISem.)	**RESEARCHMETHODOLOGY**					
	CourseCode: R23XXXX		3	0	0	3

Pre-requisites:

Course Objectives:

- Familiarizestudentswiththefundamentalsof researchprocessandmethodologies.
- Enablestudentstoidentify,formulate,anddefineresearchproblems systematically.
- Developskillsinliteraturereview,datacollection,analysis,andinterpretation.
- Exposestudentstoresearchethics,plagiarism,and intellectualproperty rights
- Trainstudentsintechnicalwriting,presentation,anddocumentationofresearchoutcomes.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C320.1	:	Explainresearch concepts,types,andtheoverallresearchprocess.
C320.2	:	Identifyanddefineresearchproblemsthroughsystematicliteraturereviewandgapanalysis.
C320.3	:	Applyappropriate researchdesign,methodology,andtoolsfordatacollectionand analysis.
C320.4	:	Interpretresearch resultsanddrawvalidconclusionsinlinewithresearchobjectives.
C320.5	:	Demonstrate awareness of research ethics, plagiarism, and intellectual property rights andPreparetechnicalreports,researchpapers,andeffectivelycommunicateresearch outcomes

UNIT–I		10	hrs

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory,empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable

Research Process: Problem Identification & Formulation – Research Question – Investigation Question–MeasurementIssues–Hypothesis–QualitiesofagoodHypothesis–NullHypothesis &AlternativeHypothesis.Hypothesis Testing–Logic&Importance

UNIT–II		10	hrs

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables

QualitativeandQuantitativeResearch: Qualitativeresearch–Quantitativeresearch–Concept ofmeasurement,causality,generalization,replication.Mergingthetwoapproaches

UNIT–III		10	hrs

Measurement: Conceptofmeasurement–whatismeasured?Problemsinmeasurementinresearch – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio

Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple RandomSample,Systematic Sample,StratifiedRandomSample &Multi-stagesampling.Determiningsizeof thesample–Practicalconsiderationsinsamplingandsample size.

UNIT–IV		10	hrs

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association

Interpretation of Data and Paper Writing– Layout of a Research Paper, Journals in Computer Science,ImpactfactorofJournals,Whenandwheretopublish?Ethicalissuesrelatedtopublishing, PlagiarismandSelf-Plagiarism

UNIT–V		10	hrs

Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline

Useoftools/techniquesforResearch:methodstosearchrequiredinformationeffectively, ReferenceManagementSoftwarelikeZotero/Mendeley,SoftwareforpaperformattinglikeLaTeX/MS Office, Software for detection of Plagiarism

TextBooks

1. **C.R.Kothari&GauravGarg**–*ResearchMethodology:MethodsandTechniques*–NewAge InternationalPublishers., 3rdEdition,2007
2. **K.N.Krishnaswamy,AppaIyerSivakumar,M.Mathirajan**–*Management Research Methodology:IntegrationofPrinciples,MethodsandTechniques* –PearsonEducation., 2009.

ReferenceBooks

1. **DonaldR.Cooper&PamelaS.Schindler**–*BusinessResearchMethods*–McGrawHill.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C320.1	3	2								3		2			
C320.2	3	2								3		2			
C320.3	3	2								3		2			
C320.4	3	2								3		2			
C320.5	3	2								3		2			
Avg.	**3**	**2**								**3**		**2**			

		L	**T**	**P**	**Cr.**

B.Tech (VIISem.)	**POWERSYSTEMOPERATIONANDCONTROL**					
	CourseCode: R2341XXXX	3	0	0	3	

Pre-requisites: Asolidknowledgeonpowersystems -I, II,systemanalysis.

Course Objectives:

- Tounderstandoptimaldispatchofgenerationwithandwithout losses.
- Tostudytheoptimal schedulingofhydrothermalsystems.
- Tostudytheoptimalunitcommitment problem.
- Tostudytheloadfrequencycontrolforsingleareasystemwithandwithout controllers
- Tostudytheload frequencycontrolfortwo areasystemwith andwithoutcontrollers
- Tounderstandthereactivepowercontrolandcompensationoftransmissionlines.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C401.1	:	AbletocomputeoptimalschedulingofGenerators.
C401.2	:	Abletounderstandhydrothermal scheduling.
C401.3	:	Understandtheunitcommitmentproblem.
C401.4	:	Abletounderstandimportanceofthefrequency.
C401.5	:	UnderstandimportanceofPIDcontrollersinsingleareaandtwoareasystems.

UNIT–I		10	hrs

EconomicOperationofPowerSystems

Optimal operation of Generators in Thermal power stations, – Heat rate curve – Cost Curve – Incremental fuel and Production costs – Input–output characteristics – Optimum generationallocationwithlinelossesneglected–Optimumgenerationallocationincludingtheeffectof transmissionlinelosses–LossCoefficients–Generaltransmissionlinelossformula.

UNIT–II		10	hrs

HydrothermalScheduling

OptimalschedulingofHydrothermalSystem**:**Hydroelectricpowerplantmodels–Scheduling problems – Short term hydrothermal scheduling problem.

UNIT–III		10	hrs

UnitCommitment

Optimalunitcommitmentproblem–Needforunitcommitment–Constraintsinunitcommitment–

Costfunctionformulation–Solutionmethods–Priorityordering–Dynamicprogramming.

UNIT–IV		10	hrs

LoadFrequencyControl-I

Modeling of steam turbine – Generator – Mathematical modeling of speed governing system – Transfer function – Modeling of Hydro turbine –Necessity of keeping frequency constant – Definitions of Control area – Single area control system – Block diagram representation of an isolated power system – Steady state analysis – Dynamic response – Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation – Steady state response.**Load Frequency Control-II**

BlockdiagramdevelopmentofLoadFrequencyControloftwoareasystemuncontrolledcaseand controlledcase.Tie-line biascontrol.LoadFrequencyControlandEconomicdispatchcontrol.

UNIT–V		10	hrs

ReactivePowerControl

Overview of Reactive Power control – Reactive Power compensation in transmission systems – Advantages and disadvantages of different types of compensating equipment for transmission systems–Loadcompensation–Specificationsofloadcompensator–Uncompensatedand compensatedtransmissionlines**:**Shuntandseries compensation–NeedforFACTScontrollers.

TextBooks

1	ElectricEnergysystemsTheory–byO.I.Elgerd,TataMcGraw–hillPublishingCompany Ltd.,Secondedition.
2	ModernPowerSystemAnalysis–byI.J.Nagrath&D.P.KothariTataMcGrawHillPublishing CompanyLtd, 2nd edition.

ReferenceBooks

1	PowerSystemAnalysisandDesignbyJ.DuncanGloverandM.S.Sarma.,Thompson,3rdEdition.
2	PowerSystemAnalysisbyGraingerandStevenson,TataMcGrawHill.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C401.1	2	3											1		3
C401.2	2	3											1		3
C401.3	2	3											1		3
C401.4	2	3											1		3
C401.5	2	3											1		3
Avg.	**2**	**3**											**1**		**3**

			L	T	P	Cr.
B.Tech (VIISem.)		**ENERGYMANAGEMENT&AUDITING**				
		CourseCode: R2341XXXX	2	0	0	2

Pre-requisites: BasicknowledgeonHVDCsystems

Course Objectives:

- Tounderstandenergyefficiency,scope,conservationandtechnologies.
- Todesignenergyefficientlightingsystems.
- Toestimate/calculatepowerfactorofsystemsandproposesuitablecompensation techniques.
- TounderstandenergyconservationinHVACsystems.
- Tocalculatelifecyclecostinganalysisandreturnoninvestmentonenergyefficient technologies.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C402.1	:	Explainenergyefficiency,conservationandvarioustechnologies.
C402.2	:	Designenergyefficientlightingsystems.
C402.3	:	Calculatepowerfactorofsystemsandproposesuitablecompensationtechniques.
C402.4	:	Understandoftypesofspaceheatingand ventilation.
C402.5	:	ExplainenergyconservationinHVACsystems.

UNIT–I		10	hrs

BasicPrinciplesofEnergyAuditandmanagement

Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Pie charts – Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems – Principles of energy management – Initiating, planning, controlling, promoting,monitoring,reporting–Energymanager–Qualitiesandfunctions–Language– Questionnaire– Check list fortop management.

UNIT–II		10	hrs

Lighting

Modification of existing systems – Replacement of existing systems – Priorities**:** Definitionof terms and units – Luminous efficiency – Polar curve – Calculation of illumination level – Illumination of inclined surfaceto beam– Luminanceorbrightness –Types oflamps –Types oflighting–Electric lightingfittings(luminaries)–Floodlighting–WhitelightLEDandconductingPolymers–

Energyconservation measures.

PowerFactorandenergyinstruments

Power factor – Methods of improvement – Location of capacitors – Power factor with non-linear loads–EffectofharmonicsonPowerfactor–Numericalproblems.EnergyInstruments–Watt–hourmeter– Dataloggers–Thermocouples–Pyrometers–Luxmeters–Tongtesters–Power analyzer.

UNIT–III		10	hrs

SpaceHeatingandVentilation

Ventilation – Air–Conditioning (HVAC) and Water Heating**:** Introduction – Heating of buildings – Transfer of Heat–Space heating methods – Ventilation and air–conditioning – Insulation–Cooling load – Electric water heating systems – Energy conservation methods.

UNIT–IV		10	Hrs

EconomicAspectsandFinancialAnalysis

Understanding energy cost -EconomicsAnalysis–Depreciation Methods–Timevalueof money–Rateofreturn–Presentworthmethod–Replacementanalysis–Lifecyclecostinganalysis– Energy efficient motors (basic concepts) – Economics of energy efficient motors and systems.

UNIT–V		10	Hrs

ComputationofEconomicAspects

Need of investment, appraisal and criteria - Calculation of simple payback period–Return on investment – Net present value – Internal rate of return – numerical examples – Power factor correction–Lighting–Applicationsoflifecyclecostinganalysis–Returnoninvestment–Numericalexamples.

TextBooks

1	HandBookofEnergyAuditbySonalDesai-Tata McGrawhill
2	Energyefficientelectric motorsbyJohn.C.Andreas,MarcelDekker IncLtd–2nd edition,1995

ReferenceBooks

1	EnergymanagementbyW.R.Murphy&G.MckayButterworth,Elsevierpublications. 2012
2	ElectricEnergyUtilizationandConservationbySCTripathy,TataMcGrawhillpublishing companyLtd.New Delhi.
3	EnergymanagementbyPaulo'Callaghan,Mc–GrawHillBookcompany–1stedition, 1998.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C402.1	2	3													

	C402.2	2	3	3												
	C402.3	2	3											2		
	C402.4	2	3											2		
	C402.5	2	3											2		
	Avg.	**2**	**3**	**3**										**2**		

		PROFESSIONALELECTIVE–IV	**L**	**T**	**P**	**Cr.**
B.Tech (VIISem)		**EHVAC&HVDCTRANSMISSIONSYSTEMS**				
		CourseCode: R2341XXX	3	0	0	3

Pre-requisites: ConversionofACpowertoDCpoweratthesendingendandthenbacktoACat thereceivingend.

Course Objectives:

- ToUnderstandbasicconceptsofHVDCTransmission.
- Toanalyzetheconverter configuration.
- ToKnowthecontrolofconverterandHVDCTransmission.
- ToUnderstandthesignificanceofreactivepowercontrolandAC/Dcloadflow.
- ToKnowdifferentconverterfaults,protectionand effectofharmonics.
- Toleavelowpassandhighpassfilters.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C403A.1	:	ExplaindifferenttypesofHVDClevelsandbasic concepts
C403A.2	:	Explaintheoperationof converters.
C403A.3	:	Analyzethe converterconfiguration.
C403A.4	:	Describecontrol concept ofreactivepowercontrol andAC/DCloadflow.
C403A.5	:	converterfaults,protectionandharmoniceffects

UNIT–I		10	hrs

BasicConcepts
Economics&TerminalequipmentofHVDCtransmissionsystems:TypesofHVDCLinks– Apparatus required for HVDC Systems – Comparison of AC &DC Transmission,Applicationof DC Transmission System – Planning & Modern trends in D.C. Transmission.

UNIT–II		10	hrs

AnalysisofHVDCConverters
Choiceofconverterconfiguration–analysisofGraetz–characteristicsof6pulse&12pulse converters – Cases of two 3 phase converters in star –star mode – their performance.

UNIT–III		10	hrs

Converter&HVDCSystemControl
PrincipalofDCLinkControl –ConvertersControlCharacteristics –Firinganglecontrol– Current andextinctionanglecontrol–Effectofsourceinductanceonthesystem-Startingandstoppingof DClink -Power Control.

UNIT–IV		10	hrs

ReactivePowerControlinHVDC

ReactivePowerRequirementsinsteadystate-Conventionalcontrolstrategies-Alternatecontrol strategies sources of reactive power-AC Filters – shunt capacitors-synchronous condensers.

PowerFlowAnalysisInAC/DCSystems

ModellingofDCLinks-DCNetwork-DCConverter-ControllerEquations-SolutionofDCload flow – solution of AC-DC Power flow-Simultaneous Method-Sequential method.

UNIT–V		10	hrs

ConverterFault&Protection

Converter faults – protection against over current and over voltage in converter station – surge arresters –smoothing reactors – DC breakers –Audible noise-space charge field-corona effects on DC lines-Radio interference.

Harmonics

GenerationofHarmonics–Characteristicsharmonics,calculationofACHarmonics,Non-Characteristicsharmonics,adverseeffectsofharmonics–Calculationofvoltage&Currentharmonics – Effect of Pulse number on harmonics.

TextBooks

1	HVDCPowerTransmission Systems: TechnologyandsystemInteractions –byK.R.Padiyar, NewAge International(P)Limited,andPublishers.
2	HVDCTransmissionbyS.KamakshaiahandV.Kamaraju-TataMcGraw–Hill

ReferenceBooks

1	HVDCTransmission–J.Arrillaga.
2	DirectCurrentTransmission–byE.W.Kimbark,JohnWiley&Sons.
3	PowerTransmisionbyDirectCurrent–byE.Uhlmann,B.S.Publications.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C403.1	2	3												3	
C403.2	2	3												3	
C403.3	2	3												3	
C403.4	2	3												3	
C403.5	2	3												3	
Avg.	**2**	**3**												**3**	

	PROFESSIONALELECTIVE–IV	**L**	**T**	**P**	**Cr.**

B. Tech (VIISem.)	PROGAMMABLELOGICCONTROLLERS& APPLICATIONS				
	CourseCode:R2341XXX	3	0	0	3

Pre-requisites: Agraspofbasicelectricalandelectronicprinciples,digitallogiccircuits,and computerprogramming concepts.

Course Objectives:

- Tohaveknowledgeon PLC.
- ToacquiretheknowledgeonprogrammingofPLC.
- TounderstanddifferentPLCregistersandtheirdescription.
- TohaveknowledgeondatahandlingfunctionsofPLC.
- ToknowhowtohandleanalogsignalandconvertingofA/Din PLC.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C403B.1	:	UnderstandthePLCsandtheirI/Omodules.
C403B.2	:	DevelopcontrolalgorithmstoPLCusingladderlogic.
C403B.3	:	DevelopcounterstoPLCusingladderlogic.
C403B.4	:	DevelopcontrolinstrumentstoPLCusingladderlogic.
C403B.5	:	ManagePLCregistersforeffectiveutilizationindifferent applications.

UNIT–I		10	hrs

Introduction

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

UNIT–II		10	hrs

PLCProgramming

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams and sequence listings, ladder diagram construction.

UNIT–III		10	hrs

ProgrammableTimersandCounters

Timer instructions – On delay time instruction – Off delay timer instruction – Retentive timer – Counter instructions – Up counter – Down counter - Cascading counters - Incremental encoder – Counter applications – Combining counter and timer functions.

UNIT–IV		10	hrs

ProgramControlInstructions

Mastercontrolresetinstruction–Jumpinstructionsandsubroutines–Immediateinputand output instructions.

UNIT–V		10	hrs

OtherInstructions

Data manipulation – Data transfer operation – Data compare instruction – Data manipulation programs – Numerical data I/O interfaces – Math instructions – Addition, subtraction, multiplication & division instruction – Sequential instructions – Sequence programs – Shift registers – Word shift registers.

Applications

Controlofwaterlevelindicator–Alarmmonitor-Conveyormotorcontrol–Parkinggarage– Ladder diagram for process control – PID controller.

TextBooks

1	ProgrammablelogiccontrollersbyFrankD.Petruzella-McGrawHill–3rdEdition.
2	ProgrammableLogicControllers–PrincipleandApplicationsbyJohnW.WebbandRonald A.Reiss, FifthEdition, PHI

ReferenceBooks

1	ProgrammableLogicControllers–ProgrammingMethodandApplicationsbyJR. HackworthandF.DHackworthJr. –Pearson,2004.
2	IntroductiontoProgrammableLogicControllers-GaryDunning-CengageLearning.
3	ProgrammableLogicControllers–W.Bolton-Elsevierpublisher

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C403B.1	2	3													1
C403B.2	2	3													1
C403B.3	2	3													1
C403B.4	2	3											1		1
C403B.5	2	3													1
Avg.	**2**	**3**											**1**		**1**

		PROFESSIONALELECTIVE–IV	**L**	**T**	**P**	**Cr.**
B. Tech (VIISem.)		**ELECTRICALDISTRIBUTIONSYSTEMS**				
		CourseCode:R2341XXX	3	0	0	3

Pre-requisites: Asolidunderstandingofbasicelectricalengineeringprinciplesandpowersystem analysis.

Course Objectives:

- Tostudydifferentfactors ofDistributionsystem.
- Tostudyanddesignthesubstationsanddistributionsystems.
- Tostudytheconceptsofvoltagedropandpowerloss.
- Tostudythedistributionsystemprotection andits coordination.
- Tostudytheeffect ofcompensationforpowerfactorimprovement.
- Tostudytheeffect ofvoltagecontrolondistribution system.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C403C.1	:	Discussthevariousfactorsofdistributionsystem.
C403C.2	:	Designthesubstationand feeders.
C403C.3	:	Determinethevoltagedropandpower loss.
C403C.4	:	Explaintheprotection anditscoordination.
C403C.5	:	Illustratetheeffectof compensationonpowerfactorimprovement.

UNIT–I		10	hrs

GeneralConcepts

Introductiontodistributionsystems,Loadmodelingandcharacteristics–Coincidencefactor–Contributionfactorlossfactor–Relationshipbetweentheloadfactorandlossfactor– Classification of loads (Residential, commercial, Agricultural and Industrial).

UNIT–II		10	hrs

Substations

Locationofsubstations**:**Ratingofdistributionsubstation–Serviceareawith‘n’primaryfeeders – Benefits and methods of optimal location of substations.

DistributionFeeders

DesignConsiderationsofdistributionfeeders**:**Radialandlooptypesofprimaryfeeders– Voltage levels – Feeder loading – Basic design practice of the secondary distribution system.

UNIT–III		10	hrs

SystemAnalysis

Voltagedropandpower–losscalculations**:**Derivationforvoltagedropandpowerlossinlines–Uniformlydistributedloadsandnon-uniformlydistributedloads–Numericalproblems-Three phase balanced primary lines.

UNIT–IV		10	hrs

Protection

Objectives of distribution system protection – Types of common faults and procedure for fault calculations for distribution system – Protective devices**:** Principle of operation of fuses – Circuit reclosures – Line sectionalizes and circuit breakers.

Coordination

Coordinationofprotectivedevices**:**Generalcoordinationprocedure–Varioustypesofco-ordinated operation of protective devices - Residual Current Circuit Breaker

UNIT–V		10	hrs

CompensationforPowerFactorImprovement

Capacitive compensation for power factor control – Different types of power capacitors – shunt and series capacitors – Effect of shunt capacitors (Fixed and switched) – Power factor correction – Capacitor allocation – Economic justification – Procedure to determine the best capacitor location – Numerical problems.

VoltageControl

Voltage Control**:** Equipment for voltage control – Effect of series capacitors – Effect ofAVB/AVR – Line drop compensation – Numerical problems.

TextBooks

1	"ElectricPowerDistributionsystem,Engineering"–byTuranGonen,McGraw–hillBook Company.

ReferenceBooks

1	ElectricalDistributionSystemsbyDaleR.PatrickandStephenW.Fardo,CRCpress
2	ElectricalPowerDistributionSystemsbyV.Kamaraju,RightPublishers.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C403C.1	2	3												3	
C403C.2	2	3												3	
C403C.3	2	3												3	
C403C.4	2	3												3	
C403C.5	2	3												3	
Avg.	**2**	**3**												**3**	

12WeekMOOCSSWAYAM NPTEL Course recommendedbyBOS

		PROFESSIONALELECTIVE–V	**L**	**T**	**P**	**Cr.**
B.Tech (VIISem.)		**ELECTRICVEHICLES**				
		CourseCode:R2341XXX	3	0	0	3

Pre-requisites: Thiscourseaimstostudyandunderstandmeritsofelectricandhybridelectric vehicles.Italsodealswithdifferentpowerelectronicconvertersandbatterystoragesystemsfor electricand hybridelectricvehicles.

Course Objectives:

- Tofamiliarizethestudentswiththeneedandadvantagesofelectricandhybridelectric vehicles.
- Toknowvariousarchitecturesofhybridelectric vehicles.
- Tounderstandthepower managementofplug-inelectric vehicles.
- Tostudyandunderstanddifferentpower convertersusedinelectricalvehicles.
- Tofamiliarizewithdifferentbatteriesandotherstoragesystems.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C404A.1	:	Knowtheconceptofelectricvehiclesandhybridelectricvehicles.
C404A.2	:	Familiarwithdifferentconfigurationofhybridelectric vehicles.
C404A.3	:	Explainthepower convertersusedinhybridelectricvehicles
C404A.4	:	Knowdifferentbatteriesandotherenergystorage systems.
C404.5	:	Representphysicalsystemsasstatemodelsanddeterminetheresponse. Understandingtheconceptsofcontrollabilityandobservability

UNIT–I		10	hrs

Introduction

Fundamentals of vehicle, components of conventional vehicle and propulsion load; Drive cycles and drive terrain. Concept of electric vehicle and hybrid electric vehicle; History of hybrid vehicles,advantagesandapplicationsofElectricandHybridElectricVehicles,differentMotors suitableforofElectricandHybridElectricVehicles.

UNIT–II		10	hrs

Hybridizationof Automobile

ArchitecturesofHEVs,seriesandparallelHEVs,complexHEVs.Plug-inhybridvehicle, constituentsofPHEV,comparisonofHEVandPHEV;FuelCellvehiclesanditsconstituents.

UNIT–III		10	hrs

Plug-inHybridElectricVehicle

PHEVsandEREVsblendedPHEVs,PHEVArchitectures,equivalentelectricrangeofblended PHEVs. Fuel economy of PHEVs, power management of PHEVs, end-of-life battery for electricpower grid support, vehicle to grid technology, PHEV battery charging.

UNIT–IV		10	hrs

PowerElectronicsinHEVs

RectifiersusedinHEVs,voltageripples;BuckconverterusedinHEVs,non-isolatedbidirectional DC-DC converter, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter,PWMrectifierinHEVs,EVandPHEVbatterychargers.

UNIT–V		10	hrs

BatteryandStorageSystems

EnergyStorageParameters;Lead–AcidBatteries;Ultracapacitors;FlywheelsSuperconducting MagneticStorageSystem;PumpedHydroelectricEnergyStorage;CompressedAirEnergy Storage-Storage Heat;EnergyStorage asanEconomic Resource.

TextBooks

1	AliEmadi,AdvancedElectricDriveVehicles,CRCPress, 2014.
2	IqbalHussein,ElectricandHybridVehicles:DesignFundamentals,CRCPress, 2003.

ReferenceBooks

1	MehrdadEhsani,YimiGao,SebastianE.Gay,AliEmadi,ModernElectric,HybridElectric andFuelCellVehicles:Fundamentals,Theoryand Design,CRCPress,2004.
2	JamesLarminie,JohnLowry,ElectricVehicle TechnologyExplained,Wiley,2003.
3	MiChris,MasrurA.,andGaoD.W.,"HybridElectricVehicle:PrinciplesandApplications withPracticalPerspectives" 1995.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C403A.1	2	3												3	
C403A.2	2	3												3	
C403A.3	2	3												3	
C403A.4	2	3												3	
C403A.5	2	3												3	
Avg.	**2**	**3**												**3**	

		PROFESSIONALELECTIVE-V	**L**	**T**	**P**	**Cr.**
B. Tech. (VIISem.)		**SWITCHEDMODEPOWER CONVERSION**				
		Coursecode:2341XXXX	3	0	0	3

Pre-requisites: Basicknowledgeonpowerelectronics.

Course Objectives:

- Understandtheprinciplesofhigh-efficiencypowerconversion.
- Analyzeanddesignnon-isolatedDC-DCconverters,includingBuck,Boost,andBuck-Boost topologies.
- Learnandapplyresonantconverterprinciples,includingZeroVoltageSwitching(ZVS).
- Analyzeanddesignclosed-loopcontrolsystemsforswitched-modepower converters.
- Developtheabilitytodesignandimplementpowerconvertersforvariousapplications.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C404B.1	:	Understand Switch Mode Power Conversion and classify the DC-to-DC Converters.
C404B.2	:	DifferentiatethevariousPowersemiconductor switches.
C404B.3	:	IllustrateIsolatedPower Conversion
C404B.4	:	Analyzetheperformance oftheMagneticComponents.
C404B.5	:	Analyzethe switching regulatorcontrol,soft-switched dc-dcpower converters

UNIT–I	10	hrs

IntroductionToSwitchModePowerConvertersAboutSwitchModePowerConversion,SMPS requirements.Cukconverters-andtheirprinciplesofoperation;continuousanddiscontinuous modes of operation.

UNIT–II	10	hrs

Thyristor Commutation Techniques Review of Recent developments in power devices for switch mode power supplies. Selection of devices, Commutation: Load Commutation, Resonant Pulse Commutation,ComplementaryCommutation,ImpulseCommutation,ExternalPulse Commutation.

UNIT–III	10	hrs

Transformer-IsolatedConvertersSingle-switchandmulti-switchtransformer-isolatedDC-DC converters.Flybackandforwardconverters;transformerisolatedhalf-bridge,fullbridge converters.Push-pullconverters.Voltagefed and current-fed converters

UNIT–IV	10	hrs

	MagneticComponentDesignMagneticcorematerialsandperformance;basicinductorand transformerdesign;practicalmagneticdesign;designaspectstobeconsideredfordesigningtransformers for specific applications – flyback, push-pull converters			
	UNIT–V		10	hrs
	Switching Regulator Control, Soft-Switched Dc-Dc Power Converters Small-signal models for switching regulators. Performance analysis and design of closed-loop system under different controlmethods,andoperatingmodes.Measurementofsmallsignaltransferfunctions.Soft SwitchedDC-DCPowerConverters-Motivation. Hard-switchingvssoft-switching.			
	TextBooks			
	1	NMohan,TMUndelandandWPRobbins,"PowerElectronics:Converters,Applications andDesign",Wiley,3rd Edition,2007		
	2	AbrahamPressman,KeithBillings,TaylorMorey,"SwitchingPowerSupplyDesign", McGraw-Hill.3rdEdition,2009		
	ReferenceBooks			
	1	K.KitSum,SwitchModePowerConversion:BasicTheoryandDesign1stEdition,Kindle Edition,2017		

CO-PO/PSOMappingMatrix

	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	C404B.1	2	3												3	
	C404B.2	2	3												3	
	C404B.3	2	3												3	
	C404B.4	2	3												3	
	C404B.5	2	3												3	
	Avg.	**2**	**3**												**3**	

		PROFESSIONALELECTIVE-V	**L**	**T**	**P**	**Cr.**
B. Tech. (VIISem.)		**DESIGNOFPV SYSTEMS**				
		Coursecode:2341XXXX	3	0	0	3

Pre-requisites:

Course Objectives:

- Provideknowledgeofsolarphotovoltaic(PV)energyconversionprinciplesandcharacteristics of solar cells.
- Developanalyticalskillstodesign andsizestandaloneand grid-connectedPVsystems.
- FamiliarizestudentswithPVmodules,arrays,balanceofsystems(BOS),andstorage technologies.
- Exposestudentstodesignconsiderations,performanceevaluation,andeconomicaspectsof PV systems.
- EnablestudentstoapplyPVdesignstandards,simulationtools,andpracticalengineering approachesforreal-world applications

CourseOutcomes: At theendofthe course, thestudentwill beable to

C404C.1	:	Explaintheprinciplesofsolarradiation,PVeffect,andelectricalcharacteristicsofsolar cells.
C404C.2	:	AnalyzeandmodelPVmodules,arrays,andtheirperformanceunderdifferent environmental conditions.
C404C.3	:	DesignstandalonePVsystemswithappropriatebatterysizing,chargecontrollers,and inverters.
C404C.4	:	Designgrid-connectedPVsystemsconsideringinverterinterfacing,MPPT,andsafety standards.
C404C.5	:	EvaluatetheperformanceReliability,andeconomicfeasibilityofPVsystemsforvarious applicationsandApplysimulationtoolsanddesignstandardstosolvereal-worldPV systemdesign problems.

UNIT–I		10	Hrs

ReviewofEnergyScenarioandSemiconductorPhysics:

Review of world energy scenario including contribution from photovoltaic - The solar resource - Availability of energy from the sun and geographic availability - Direct diffuse and global isolation - Conceptofairmass-Definitionofsolargeometricterms-Solaraltitude-Inclinationofcollector-

Azimuth angle (solar & surface) - Declination - Incident angle - Hour angle - Solar constant - Zenith angle etc . Review of semiconductor physics: Semiconductors as solar cell material - Arrangement of atoms in space - Arrangement of electrons in atom - Formation of energy bands - Direct and indirect band gap - Charge carriers and their motion in semiconductors - Charge carriers -Carrier concentration anddistribution-Carriermotion-Electricfieldandenergybandbending(densityofstates,drift,and diffusion).

UNIT–II		10	Hrs

SolarCellDesign:

Upper limits of cell parameters - Short circuit current - Open circuit voltage - Fill factor - Efficiency - Lossesinsolarcells-Modelofasolarcell(equivalentcircuit-onediodeandtwodiodemodels) -Effect of series and shunt resistances on efficiency - Effect of solar radiation on efficiency - Effect of temperature on efficiency - Solar Cell design - Design for high Isc - High Voc - High FF - Analytical techniques - Solar simulator - I-V measurement - Quantum efficiency (QE) measurement - Minority carrier lifetime and diffusion length measurements Standard test conditions (STC) - Normal operating celltemperature(NOC)-Standardoperatingconditions(SOC)-SeriesandparallelconnectionofPV modules-Mismatchinseriesandparallelconnections-Needforbypassandblockingdiodes.

UNIT–III		10	Hrs

BalanceofSystems:

Batteries for PV Systems - Lead acid - Nickel Cadmium - Nickel metal hydride - Lithium ion - Factors impacting battery performance - DC to DC Converters -Charge controllers - Maximum Powerpoint Trackers(MPPT)-Inverters-Grid Tied-Off Grid-Hybrid Inverters-Variable Frequency Drive - Types - Setpoints-Algorithm(forMPPT)-Mountingstructures-SingleAxis-DualAxis-MaximumPowerpoint Tracking-Junctionboxes-Arraycombinerboxes-Cables-Protectiondevices-Earthing-Lightning arrestor andothersafetyissues.

UNIT–IV		10	Hrs

PVSystemDesignandApplications:

Standalone PV systems - Lighting - Water pumping - Hybrid PV Systems - PV wind and PV diesel - Grid connected PV Systems - PV power plants - Roof top and ground mounted small & large power plants.

UNIT–V		10	Hrs

EvaluationsofPVSystemsandPVPowerPlants:

Sensors and data acquisition system - Typical instruments and sensors used - Pyranometer - Anemometer/wind vane - Ambient temperature measuring device - Thermocouples to measure cell temperature - DC and AC energy meters - I-V curve tracers (or Array testers) - IR Thermal Imager - Inverters - Data logger - Server - Web-based software –Latest and Emerging trends in solar cell technologies (organic, dye sensitized, quantum dots, thermo-photovoltaic)-Laser Grooved Buried Contact(LGBC)-Passive Emitter Rear Locally diffused(PERL)-Passive Rear Contact Cells Selecting Emitter(PERC)-Peroskvite Cells-Graphene Based Solar Cells- Environmental impact of photovoltaic - Economicanalysis(netpresentvalue-Simplepayback-Capitalrecoveryfactor-Discountedcashflow analysis)-Life cycle costing(example:SolarPVpumping system).

TextBooks

1	SolarPhotovoltaics:Fundamentals,TechnologiesandApplications,ChetanSinghSolanki,PHI LearningPrivateLimited 2011(orlateredition).
2	SolarCells:OperatingPrinciples,TechnologyandSystemApplications,MartinA,Green, PrenticeHall Inc.

ReferenceBooks

1 AguidetothePhotovoltaicRevolution, PaukD. MaycockandEdward N. Stirewalt,Rodale Press, Emmaus,Pa.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C404.1	2	3												3	
C404.2	2	3												3	
C404.3	2	3												3	
C404.4	2	3												3	
C404.5	2	3												3	
Avg.	**2**	**3**												**3**	

12WeekMOOCSSWAYAM NPTEL Course recommendedbyBOS

		OPENELECTIVE-III	**L**	**T**	**P**	**Cr.**
B.Tech. (VII_Sem.)		**BATTERYMANAGEMENTSYSTEMSANDCHARGING STATIONS**				
		CourseCode:2341XXXX	3	0	0	3

Pre-requisites: The objective of this course is to introduce learner to batteries, its parameters, charging requirements and modelling. The course will help learner to understand the types of batteriesandtheirchargingmethods,developbatterymanagementandmodellingalgorithmsfor batteries.

Course Objectives:

1. ToUnderstandtheworkingofdifferentbatteriesforEVapplications
2. Toknowthefundamentalsofbatterychargingmethodsandtheir advantages
3. Toknowthedifferentkindsofequipmentinchargingstation
4. Toknowtherequirementsofbatterymanagement.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C405A.1	:	Describetheconstructionandoperationofdifferentbatteriesfor EV applications
C405A.2	:	Describechargingalgorithmsofdifferentbatteriesandbalancingmethodsof battery packs
C405A.3	:	Describethedifferentkindsofinfrastructureneededin thecharging stations
C405A.4	:	Describetherequirementsofbatterymanagementandtheirmaintenance.
C405A.5	:	Obtainthemodelling ofbatteriesanddevelop theirsimulation models.

UNIT–I		10	hrs

EVBatteries

Cells&Batteries,Nominalvoltageandcapacity,Crate,Energyandpower,Cellsconnectedin series, Cells connected in parallel.

Lead Acid Batteries: Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries.

Nickel-basedBatteries: Nickelcadmium,Nickelmetalhydridebatteries.

Sodium-Based Batteries:Introduction, sodiumSulphur batteries,sodium metalchloride (Zebra) batteries.

LithiumBatteries:Introduction,thelithiumpolymerbattery,lithium-ionbattery.

UNIT–II		10	hrs

	Batterycharging strategies Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisonsofchargingalgorithmsandnewdevelopment;Balancingmethodsforbatterypack charging:BatterysortingOverchargeforbalancing,Passivebalancing,Activebalancing.			
	UNIT–III		10	hrs
	ChargingInfrastructure DomesticChargingInfrastructure,PublicchargingInfrastructure,NormalChargingStation, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.			
	UNIT–IV		10	hrs
	Battery-Management-SystemRequirements Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, CommunicationviaCANbus,Logbook,SOCestimation,Energyestimation,Powerestimation, Diagnostics.			
	UNIT–V		10	hrs
	BatteryModelling General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.			
	TextBooks			
	1	ElectricVehiclesTechnologyExplainedbyJamesLarminieOxfordBrookesUniversity, Oxford,UKJohnLowry AcentiDesignsLtd.,Uk. (Unit-1)		
	2	EnergySystemsforElectricandHybridVehiclesbyK.T.Chau,IETPublications,First edition,2016.(Unit-2)		
	ReferenceBooks			
	1	Modern ElectricVehiclesTechnologybyC.C.Chan,K.TChau,OxfordUniversityPressInc., Newyork2001.(Unit-3)		
	2	BatteryManagementSystemsVol.–IIEquivalentCircuitsandMethods,byGregoryL.Plett, ArtechHousepublisher, Firstedition2016.(Unit-4)		
	3	BatteryManagementSystems:designbyModellingbyHenkJanBergveld,WandaS.Kruijt, SpringerScience&BusinessMedia,2002. (Unit-5)		

CO-PO/PSOMappingMatrix

	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	C405A.1	2	3											3		
	C405A.2	2	3											3		
	C405A.3	2	3											3		
	C405A.4	2	3											3		
	C405A.5	2	3											3		
	Avg.	**2**	**3**											**3**		

		OPENELECTIVE– III	**L**	**T**	**P**	**Cr.**
B.Tech. (VII_Sem.)		**CONCEPTSOFSMARTGRIDTECHNOLOGIES**				
		CourseCode: 2341XXXX	3	0	0	3

Pre-requisites: BasicUnderstandingofPowerSystemandPowerElectronics Engineering.

Course Objectives:

- Tolearnaboutrecenttrendsingridsassmartgrid
- Tounderstandaboutsmartgridarchitectureandtechnologies.
- Toknowaboutsmartsubstations.
- Tolearn aboutsmart transmission systems.
- Tolearnabout smartdistribution systems.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C405B.1	:	ExplainthetrendsinSmartGrids.
C405B.2	:	Analysetheneedsandrolesofsmart substation.
C405B.3	:	Analysetheneedsandrolesofsmarttransmission system
C405B.4	:	Computetheneedsandrolesofsmartdistributionsystem
C405B.5	:	DistinguishbetweenSCADAandDSCADAsystemsinpracticalworking environment

UNIT–I		10	Hrs

IntroductiontoSmartGrid

Working definitions of Smart GRID AND Associated concepts - -Smart Grid Functions – Traditional Power Grid and Smart Grid – New technologies for Smart Grid – Advantages – Indian Smart Grid – Key challenges for Smart Grid.

Smart Grid Architecture: Components and Architecture of Smart Grid design – Review of the proposedarchitecturesforSmartGrid.ThefundamentalcomponentsofSmartGriddesigns– TransmissionAutomation-DistributionAutomation–Renewable Integration.

UNIT–II		10	Hrs

SmartGrid Technologies

Characteristics of Smart Grid, Micro grids, Definitions, Drives, benefits, types of Micro Grid building blocks, Renewable energy resources, needs in Smart Grid, Integration impact, Integration standards, Load frequency control, reactive power control, case studies and test beds.

UNIT–III		10	Hrs

Smart Substations

Protection,Monitoringandcontroldevices,sensors,SCADA,Masterstations,Remoteterminal unit,InteroperabilityandIEC61850,Processlevel,Baylevel,Stationlevel,Benefits,roleof substations and Smart Grid, Volt / VAR control equipment inside substation.

UNIT–IV		10	Hrs

Smart Transmission

Energy management systems, History, current technology, EMS for the smart grid, wide area monitoring systems (WAMS), protection & control (WAMPC), needs in smart grid, role of substationsinsmartgriddriversandbenefits,Roleoftransmissionsysteminsmartgrid,synchro phasormeasurementunits(PMUS)

UNIT–V		10	Hrs

SmartDistributionSystems

DMS, DSCADA, trends in DSCADA and control, current and advanced DMS's, voltage fluctuations, effect of voltage on customer load, Drivers, objectives and benefits, voltage-VAR controlequipment ondistribution feeders,implementation andoptimization,FDIR-Fault Detection IsolationandServicerestoration(FDIR),Faults,objectivesandbenefits,equipment, implementation.

TextBooks

1	StuartBorlase,smartGrids-Infrastructure, TechnologyandSolutions,CRCPressI.e,2013
2	GilMasters,RenewableandEfficientElectricPowerSystems,Wiley-Press,2e,2013.

ReferenceBooks

1	A.G.PhadkesandJ.S.Thorp,SynchromizedPhasorMeasurementsandtheirApplications SpringerEdition,2e,2017.
2	T.Ackermann,WindPowerinPowerSyetems,Hoboken,NJ,USA,John Wiley,2e, 2012.
3	PowerSystemstability&control -PrabhaKundur-TMH-1994.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C405B.1	2	3											3		
C405B.2	2	3											3		
C405B.3	2	3											3		
C405B.4	2	3											3		
C405B.5	2	3											3		
Avg.	**2**	**3**											**3**		

		OPENELECTIVE-III	**L**	**T**	**P**	**Cr.**
B.Tech (VIISem)		**ADVANCEDCONTROLSYSTEMS**				
		CourseCode: R23XXXXXX	3	0	0	3

Pre-requisites: Asolidfoundationincorecontrolsystemsconceptsandstrongmathematical skills.

Course Objectives:

- Reviewofthestatespacerepresentationofacontrolsystem**:**Formulationofdifferent models from the signal flow graph, diagonalization.
- To introduce the concept of controllability and observability. Design by pole placement technique.
- AnalysisofanonlinearsystemusingDescribingfunctionapproachandPhaseplan analysis.
- TheLypanov'smethodofstabilityanalysisofasystem.
- Formulationof Euler Laugrange equation for theoptimization of typical functionalsandsolutions.
- Formulationof linear quadratic optimal regulator(LQR)problem byparameter adjustmentandsolvingriccattiequation.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C405C.1	:	Statespacerepresentationofcontrolsystemandformulationofdifferentstate modelsarereviewed.
C405C.2	:	Abletodesignofcontrolsystemusingthepoleplacementtechniqueisgiven afterintroducingthe conceptofcontrollabilityandobservability.
C405C.3	:	Abletoanalyseofnonlinearsystemusingthedescribingfunctiontechniqueand phaseplane analysis.
C405C.4	:	Ableto analyse thestabilityanalysis usinglypnov method.
C405C.5	:	Minimizationoffunctionalsusingcalculusofvariationstudied.

UNIT–I	10	hrs

Statespaceanalysis

StateSpaceRepresentation–Solutionofstateequation–Statetransitionmatrix,–Canonicalforms – Controllable canonical form – Observable canonical form, Jordan Canonical Form.

UNIT–II	10	hrs

Controllability,observabilityanddesignofpoleplacement

Tests for controllability and observability for continuous time systems – Time varying case – Minimum energy control – Time invariant case – Principle of duality – Controllability and observabilityformJordancanonicalformandothercanonicalforms–Effectofstatefeedbackon controllabilityandobservability –Designofstatefeedbackcontrolthroughpole placement.

UNIT–III	10	hrs

Describingfunctionanalysis

Introductiontononlinear systems,Typesof nonlinearities,describingfunctions,Introductionto phase–plane analysis.

UNIT–IV		10	hrs

Stabilityanalysis

Stability in the sense of Lyapunov – Lyapunov's stability and Lypanov's instability theorems – Direct method of Lyapunov for the linear and nonlinear continuous time autonomous systems.

Calculusofvariations

Minimizationoffunctionalofsinglefunction –Constrainedminimization–Minimumprinciple– Control variable inequality constraints – Control and state variable inequality constraints – Euler lagrangine equation

UNIT–V		10	hrs

Optimalcontrol

LinearQuadraticOptimalRegulator(LQR)problemformulation–Optimalregulatordesignby parameteradjustment(Lyapunovmethod)–OptimalregulatordesignbyContinuousTime AlgebraicRiccattiequation(CARE)-OptimalcontrollerdesignusingLQGframework.

TextBooks

1	ModernControlEngineering–byK.Ogata,PrenticeHallof India,3rdedition,1998
2	AutomaticControlSystemsbyB.C.Kuo,PrenticeHallPublication

ReferenceBooks

1	ModernControlSystemTheory–byM.Gopal,NewAgeInternationalPublishers,2nd edition,1996
2	ControlSystemsEngineeringbyI.J.NagarathandM.Gopal,NewAgeInternational(P)Ltd.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C405C.1	2	3											3		
C405C.2	2	3											3		
C405C.3	2	3											3		
C405C.4	2	3											3		
C405C.5	2	3											3		
Avg.	**2**	**3**											**3**		

	OPENELECTIVE-IV	**L**	**T**	**P**	**Cr.**
B.Tech (VIISem).	**CONCEPTSOFPOWERQUALITY**				
	CourseCode: R23XXXXXX	3	0	0	3

Pre-requisites: CircuitandNetworks,BasicElectricalEngineering,PowerElectronics,Power System,andLinearControl System.

Course Objectives:

- Tolearndifferenttypesofpowerqualityphenomena.
- Toidentifysourcesforvoltagesag,voltageswell,interruptions,transients,long duration over voltages and harmonics in a power system.
- Todescribepowerqualitytermsandstudypowerqualitystandards.
- Tolearntheprincipleofvoltageregulationandpowerfactorimprovement methods.
- Toexplaintherelationshipbetweendistributedgenerationandpowerquality.
- Tounderstandthepowerqualitymonitoringconceptsandtheusageofmeasuring instruments.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C406A.1	:	Differentiatebetweendifferenttypesofpowerqualityproblems.
C406A.2	:	Explainthesourcesofvoltagesag,voltageswell,interruptions,transients,long durationovervoltages andharmonicsinapowersystem.
C406A.3	:	Analyzepowerqualitytermsandpowerqualitystandards.
C406A.4	:	Explaintheprincipleofvoltageregulationandpowerfactorimprovementmethods.
C406A.5	:	Demonstratetherelationshipbetweendistributedgenerationandpowerquality.

UNIT–I		10	hrs

Introduction

Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltagevariations–Voltageunbalance–Waveformdistortion–Voltagefluctuation–Power frequencyvariations.

UNIT–II		10	hrs

Voltageimperfectionsinpowersystems

Powerqualityterms–Voltagesags–Voltageswellsandinterruptions–Sourcesofvoltagesag, swellandinterruptions–Nonlinearloads–IEEEandIECstandards.Sourceoftransientover voltages–Principlesofovervoltageprotection–Devicesforovervoltageprotection–Utility capacitorswitching transients.

UNIT–III		10	hrs

VoltageRegulationandpowerfactorimprovement:

Principlesofregulatingthevoltage– Deviceforvoltageregulation–Utilityvoltage regulatorapplication–Capacitorforvoltageregulation–End–usercapacitorapplication– Regulatingutilityvoltagewithdistributedresources–Flicker–Powerfactorpenalty–StaticVAR compensationsforpowerfactor improvement.

UNIT–IV		10	hrs

Harmonicdistortionandsolutions

Voltagedistortionvs.Currentdistortion–Harmonicsvs.Transients–Harmonicindices–Sources ofharmonics–Effectofharmonic distortion–Impact of capacitors,transformers, motors andmeters–Pointofcommoncoupling –Passiveandactivefiltering –Numericalproblems.

UNIT–V		10	hrs

DistributedGenerationandPowerQuality

Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks.

MonitoringandInstrumentation

Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data – Application of intelligent systems – PQ monitoring standards.

TextBooks

1	ElectricalPowerSystemsQuality,DuganRC, McGranaghanM F,SantosoS,andBeatyHW, SecondEdition,McGraw–Hill,2012, 3rdedition.
2	Electricpowerqualityproblems–M.H.J.BollenIEEEseries-WileyIndiapublications,2011.

ReferenceBooks

1	PowerQualityPrimer,KennedyBW,FirstEdition,McGraw–Hill,2000.
2	UnderstandingPowerQualityProblems:VoltageSagsandInterruptions,BollenMHJ,First Edition,IEEEPress;2000.
3	PowerSystemHarmonics,ArrillagaJandWatsonNR,SecondEdition,JohnWiley&Sons 2003.
4	ElectricPowerQualitycontrolTechniques,W.E.KazibweandM.H.Sendaula,VanNostrad Reinhold,New York.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C406A.1	2	3											3		
C406A.2	2	3											3		
C406A.3	2	3											3		

	C406A.4	2	3											3		
	C406A.5	2	3											3		
	Avg.	**2**	**3**											**3**		

	OPENELECTIVE-IV	L	T	P	Cr.
B. Tech. (VIISem.)	**INTELLIGENTOFCONTROL SYSTEMS**				
	Coursecode:23XXXXXX	3	0	0	3

Pre-requisites: This course covers mathematical modeling, time response, frequency response, stability analysis of Linear Time Invariant (LTI) control systems and their analysis. State space analysisofLTIsystemsanddesignofcompensatorusingBodediagramsisalsodiscussedinthis course.

Course Objectives:

- To learn the mathematical modelling of physical systems and to use block diagram algebraand signal flow graph to determine overall transfer function.
- Toanalyzethetimeresponseoffirstandsecondordersystemsandimprovementof performance using PI, PD, PID controllers.
- To investigate the stability of closed loop systems using Routh's stability criterion and root locus method.
- To learn Frequency Response approaches for the analysis of LTI systems using Bode plots, polar plots and Nyquist stability criterion.
- TolearnstatespaceapproachforanalysisofLTIsystemsandunderstandtheconceptsof controllabilityandobservability.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C406B.1	:	Derivethetransferfunctionofphysicalsystemsanddeterminationofoveralltransfer functionusingblockdiagramalgebraandsignalflowgraphs.
C406B.2	:	Determinetimeresponsespecificationsofsecondordersystemsandtodetermine error constants.
C406B.3	:	AnalyzeabsoluteandrelativestabilityofLTIsystemsusingRouth'sstabilitycriterion andtherootlocus method.
C406B.4	:	AnalyzethestabilityofLTIsystemsusingfrequencyresponse methods.
C406B.5	:	Represent physical systems as state models and determine the response. Understandingtheconceptsofcontrollabilityandobservability

UNIT–I		10	hrs

MathematicalModellingofControl Systems

Classificationofcontrolsystems-openloopandclosedloopcontrolsystemsandtheirdifferences-

transferfunctionoflinearsystem-differentialequationsofelectricalnetworks-translationaland rotationalmechanicalsystems–blockdiagramalgebra– Feedbackcharacteristics.

UNIT–II		10	hrs

TimeResponse Analysis
Standardtestsignals–timeresponseoffirstandsecondordersystems–timedomainspecifications -steadystateerrors anderrorconstants -P-PI&PID Controllers.

UNIT–III		10	hrs

StabilityandRootLocus Technique
Theconceptofstability–Routh-HurwitzCriteria–limitationsofRouth-Hurwitzcriterion-.Root locus concept – construction of root loci (simple problems).

UNIT–IV		10	hrs

FrequencyResponse
Analysis Introduction to frequency domain specifications – Bodediagrams– Transferfunction from the Bode diagram – phase margin and gain margin.

UNIT–V		10	hrs

StateSpaceAnalysisofLinearTimeInvariant(LTI)Systems
Concepts of state - state variables and state model - state space representation of transfer function - State Transition Matrix and it's properties - concepts of controllability and observability.

TextBooks

1	ModernControlEngineering byKotsuhiko Ogata-PrenticeHallofIndia.
2	AutomaticcontrolsystemsbyBenjaminC. Kuo-PrenticeHallof India-2ndEdition.

ReferenceBooks

1	ControlSystemsprinciplesanddesignbyM. Gopal -TataMc GrawHilleducationPvtLtd. -4thEdition
2	ControlSystemsEngineeringbyI.J.NagarathandM.Gopal-NewageInternational Publications-5thEdition.
3	ControlSystemsEngineeringbyS. Palani-Tata McGraw HillPublications.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C406B.1	2	3											3		
C406B.2	2	3											3		
C406B.3	2	3											3		
C406B.4	2	3											3		
C406B.5	2	3											3		
Avg.	**2**	**3**											**3**		

		OPENELECTIVE-IV	**L**	**T**	**P**	**Cr.**

B.Tech. (VII_Sem.)	INSTRUMENTATION				
	Course Code:23XXXXXX	3	0	0	3

Pre-requisites: This course introduces the principle of operation of basic analog and digital measuring instruments for measurement of current, voltage, power, energy etc. Measurement of resistance, inductance and capacitance by using bridge circuits will be discussed in detail. It is expectedthatstudentwillbethoroughwithvariousmeasuringtechniquesthatarerequiredforan electricalengineer.

Course Objectives:

- Tostudytheprincipleofoperationandworkingofdifferenttypesofinstrumentsfor measurement of Electrical Quantities.
- Tostudytheworkingprincipleofoperationofdifferenttypesofinstrumentsformeasurement of power and power factor.
- Tounderstandtheprincipleofoperationandworkingofvarioustypesofbridgesformeasurement of parameters –resistance, inductance, capacitance and frequency.
- Tounderstandtheprincipleof operationandworkingof transducers.
- To study the principle of operation and working of DVMS, Power analyser and applications of CRO.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C406C.1	:	Selectrighttype ofinstrumentfor measurementof AC andDCElectrical quantities.
C406C.2	:	Explaintheconstructionandworkingofmetersusedformeasurementofpower and power factor.
C406C.3	:	Analyzesuitablebridgesformeasurementofelectrical parameters.
C406C.4	:	Illustratetheoperationof differenttypesofTransducers.
C406C.5	:	SummarizeDigitalmetersandComputefrequencyandphasedifference between signalsusingCRO.

UNIT–I		10	hrs

AnalogAmmeterandVoltmeters

Classification–deflecting,controlanddampingtorques,–PMMC,movingirontypeand electrostaticinstruments,Construction,Torqueequation,Rangeextension,Effectoftemperature, Errorsandcompensations,advantagesanddisadvantages.Instrumenttransformers:Current TransformerandPotentialTransformer-construction,theory,errors-Numerical Problems.

UNIT–II		10	hrs

AnalogWattmeter'sandPowerFactor Meters

Electrodynamometer type wattmeter (LPF and UPF), Power factor meters: Dynamometer and M.I type (Single phase and three phase), construction, theory, torque equation, advantages and disadvantages -Numerical Problems.

UNIT–III		10	hrs

MeasurementsofElectrical parameters:

DC Bridges: Method of measuring low, medium and high resistance – sensitivity of Wheat stone's bridge, Kelvin's double bridge for measuring low resistance, Loss of charge method for measurement of high resistance, Megger – measurement of earth resistance - Numerical Problems.

ACBridges:Measurementofinductance–qualityfactor,Maxwell'sbridge,Hay'sbridge, Anderson's bridge, measurement of capacitance and loss angle, Desauty's bridge, Schering Bridge, Wagner's earthing device, Wien's bridge- Numerical Problems.

UNIT–IV		10	hrs

Transducers

Definition,Classification,Resistive,InductiveandCapacitiveTransducer,LVDT,StrainGauge, Thermistors, Thermocouples, Piezo electric and Photo Diode Transducers, Digital shaft encoders,Hall effect sensors- Numerical Problems.

UNIT–V		10	hrs

Digital meters

Digital voltmeter – Successive approximation DVM, Ramp type DVM and Integrating type DVM – Digital frequency meter, Digital multimeter, Digital tachometer, Digital Energy Meter, LCR Q meter,PowerAnalyzer-Measurementofphasedifference,Frequency,hysteresisloopusing lissajiouspatternsinCRO-Numerical Problems.

TextBooks

1	ElectricalMeasurementsandmeasuringInstrumentsbyE.W.GoldingandF.C.Widdis,fifth Edition,Wheeler Publishing.
2	ModernElectronicInstrumentationandMeasurementTechniquesbyA.D.HelfrickandW.D. Cooper,PHI,5thEdition,2002.

ReferenceBooks

1	Electrical&ElectronicMeasurement&InstrumentsbyA.K.SawhneyDhanpatRai&Co. Publications.
2	ElectricalandElectronicMeasurementsandinstrumentationbyR.K.Rajput,S.Chand. Publications.
3	ElectricalandElectronicMeasurementsbyG.K.BanerjeePHILearningPrivateLtd,New Delhi–2012.

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C406C.1	2	3											3		

	C406C.2	2	3											3		
	C406C.3	2	3											3		
	C406C.4	2	3											3		
	C406C.5	2	3											3		
	Avg.	**2**	**3**											**3**		

			L	T	P	Cr.
B.Tech. (VII Sem.)		**POWERSYSTEMSANDSIMULATION LABORATORY**				
		CourseCode: 23XXXXXX	0	0	4	2

Pre-requisites:

Course Objectives:

Toimpartthepracticalknowledgeoffunctioningofvariouspowersystemcomponentsanddeterminationofvariousparametersandsimulationofloadflows,transientstability,LFCand Economicdispatch.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C407.1	:	Compilethedata,organizeandanalyzeitfordiscussionandreportthefindingsand observationsfromexperimentallearningactivitiesinthe laboratory.
C407.2	:	Buildholisticdevelopmentandpleasingdispositionbyreviewingandcorrectingthe performancetobecomeindependentand autonomous thinker.
C407.3	:	**S**imulateand plot the Reponsesofdifferent power electronicconvertersand load frequency controlofapowersystemWithandWithoutControlandeconomicdispatchofapower systemWithandWithoutlossesusingMATLABSoftware.
C407.4	:	DeterminesequenceimpedancesofthreephasealternatorandABCDparametersofa transmissionline.

List ofExperiments

(Anyofthe 5experimentsarerequiredto be conducted ineach PART)

	PART-A:PowerSystems
1	Estimationof sequenceimpedancesof3-phaseTransformer.
2	Estimationofsequenceimpedancesof 3-phaseAlternatorby Fault Analysis.
3	Estimationofsequenceimpedancesof3-phaseAlternatorbyDirect method.
4	EstimationofABCDparametersontransmissionline model.
5	Performanceof longtransmission linewithout compensation.
6	Performanceof longtransmission linewith shunt compensation.
7	Analyzethe Ferrantieffectonlongtransmissionline.
	PART-B:Simulation

	9	DeterminationofY-bus usingdirectinspection method.
	10	LoadflowsolutionofapowersystemnetworkusingGauss-Seidelmethod
		.
	11	LoadflowsolutionofapowersystemnetworkusingNewtonRaphson method.
	12	FormationofZ_busbybuildingalgorithm.
	13	Economicload dispatch with &without losses.
	14	Loadfrequencycontrolof atwoareaPowerSystem without &with PIcontroller.
	15	TransientStabilityanalysisofsinglemachineconnectedtoaninfinitebus(SMIB)usingequalarea criterion.
	ReferenceBooks:	
	1	MicroprocessorsandMicrocontrollers-Architecture,ProgrammingandSystemDesignbyKrishna Kant,PHILearningPrivateLimited,SecondEdition,2014.
	2	MicroprocessorsandMicrocontrollersbyN.SenthilKumar,M.SaravananandS.Jeevananthan, OxfordUniversityPress,SeventhImpression2013

CO-PO/PSOMappingMatrix

	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	C407.1									2	3		2			
	C407.2								2	2	3		2			
	C407.3					3									2	
	C407.4					3							2		2	
	Avg.					**3**			**2**	**2**	**3**		**2**		**2**	

			L	T	P	Cr.
B. Tech. (VIISem)		**CONSTITUTIONOF INDIA**				
		CourseCode: 23XXXXXX (CommontoEEE,CSE,IT, CSE(AI&ML))	2	0	0	0

Pre-requisites: Basicsocietal knowledge

Course Objectives:

- Enablethestudent to understandthe importanceofconstitution.
- Understandthestructure ofexecutive,legislature andjudiciary.
- Understandphilosophyoffundamentalrightsandduties.
- Understandtheautonomousnatureofconstitutionalbodieslike SupremeCourtandhigh court controller and auditor general of India and election commission of India.
- Understandthe central andstaterelationfinancialandadministrative.

CourseOutcomes: At theendofthe course, thestudentwill beable to

C408.1	:	Explaintheimportanceandthefeaturesof Indian Constitution.
C408.2	:	IdentifythestructureandpowersofUnionGovernmentandtheadministrationofthe IndianUnion.
C408.3	:	Explainthestructure andadministrationofStateGovernment
C408.4	:	DistinguishthreetiergovernmentsystemofLocalAdministration.
C408.5	:	UnderstandthepurposeofElectionCommissionandNitiAayoginnational developmentanddemocracy.

UNIT–I — 10 hrs

IntroductiontoIndianConstitution:Constitutionmeaningoftheterm,IndianConstitution -Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

Learningoutcomes:Aftercompletionofthisunitstudentwillunderstandtheconceptof Indian constitution

- Applytheknowledgeon directiveprincipleofstate policy
- AnalyzetheHistory,featuresof Indianconstitution
- EvaluatePreamble FundamentalRightsandDuties

UNIT–II — 10 hrs

	Union Government and its Administration Structure of the Indian Union: Federalism, Centre State relationship,President:Role,powerandposition,PMandCouncilofministers,CabinetandCentral Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions; Learning outcomes: -After completion of this unit student will • Understandthestructureof Indiangovernment • Differentiatebetweenthestateandcentralgovernment • ExplaintheroleofPresident and Prime Minister • KnowtheStructureofsupremecourt			
	UNIT–III		10	hrs
	StateGovernmentanditsAdministrationGovernor-RoleandPosition-CMandCouncilofministers, State Secretariat: Organization, Structure and Functions Learningoutcomes:-Aftercompletionofthisunitstudent will • Understandthestructure ofstate government • AnalyzetheroleGovernor andChief Minister • Explaintheroleof stateSecretariat • Differentiatebetweenstructureand functionsofstatesecretariat			
	UNIT–IV		10	hrs
	Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation Panchayati Raj: Functions PRI: ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: Block level OrganizationalHierarchy-(Differentdepartments),Villagelevel-RoleofElectedandAppointed officials - Importance of grass root democracy Learningoutcomes:-Aftercompletionofthisunitstudent will • UnderstandthelocalAdministration • Compareandcontrastdistrictadministrationroleand importance • Analyzethe roleofMayerandelectedrepresentativesof Municipalities • EvaluateZillapanchayat blocklevelorganization			
	UNIT–V		10	hrs
	ElectionCommission:ElectionCommission-RoleofChiefElectionCommissionerandElection Commissioner ate State Election Commission: FunctionsofCommissionsforthewelfareofSC/ST/OBCandwomen Learning outcomes: -After completion of this unit student will • KnowtheroleofElectionCommissionapplyknowledge • ContrastandcomparetheroleofChiefElectioncommissionerandCommissionerate • Analyzeroleof state election commission • Evaluatetherole ofstatesinnationaldevelopmentpriorities,sectorsandstrategies.			
	TextBooks			
	1	DurgaDasBasu,IntroductiontotheConstitutionof India,Prentice –HallofIndiaPvt.Ltd., NewDelhi		

	2	SubashKashyap, IndianConstitution,NationalBook Trust
	3	J.A.Siwach,Dynamicsof IndianGovernment&Politics
	4	D.C.Gupta,IndianGovernmentandPolitics
	5	H.M.Sreevai,ConstitutionalLawofIndia,4theditionin3volumes(UniversalLaw Publication)

	e-resources	
	1	https://lecturenotes.in/video-tutorial/63226-constitution-of-india?reading=true
	2	https://lecturenotes.in/s/910-constitution-of-india-ci/videos

CO-PO/PSOMappingMatrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C408.1						2		2	1			1			
C408.2						2		2	1			1			
C408.3						2		2	1			1			
C408.4						2		2	1			1			
C408.5						2		2	1			1			
Avg.						**2**		**2**	**1**			**1**			

	EVALUATIONOFINDUSTRYINTERNSHIP	L	T	P	Cr.
B.Tech. (VIISem.)					
	CourseCode: 23XXXXXX	0	0	0	2

Pre-requisites: BasicElectrical and Electronics

Course Objectives:

- Gainknowledgethrough fieldpracticeandexperientiallearning(PO5)
- To Apply knowledge of engineering techniques, tools and resources on the project appropriate to the internship program (PO1, PO2)
- ToUnderstandtheimplicationofsolutionsprovidedonsocietyand environment(PO6and 7)
- Learning of professional ethics and develop ability to work effectively as a member and leader in teams. (PO 8 and 9)
- Communicateeffectively(oralandwrittencommunication,reportwriting,presentationskills). (PO 10)

Toidentifyandaddresstheirowneducationalneedsinachangingworldinwayssufficientto maintaintheircompetence.(PO12)

CourseOutcomes: At theendofthe course, thestudentwill beable to

C409.1	:	Gainknowledgethrough fieldpracticeandexperientiallearning
C409.2	:	Applyknowledgein applicationofengineeringtechniques, toolsand resourceson the projectappropriatetothe internshipprogram
C409.3	:	Applyappropriateknowledgeandskillstoidentify,formulate,analyze,andsolve complexengineeringproblemsinordertoreachsubstantiatedconclusions
C409.4	:	Applyprofessionalengineeringknowledgetoassesssocietal,health,safety,legalissues andEconomicalfeasibility.Identifytheimportanceandmethodsofenvironment protection & sustainability
C409.5	:	Learningofprofessional ethicsanddevelop abilitytoworkeffectivelyasa memberand leaderinteams
C409.6		Communicateeffectively(oralandwrittencommunication,reportwriting, presentation skills)
C409.7		Identifyandtoaddresstheirowneducationalneedsinachangingworldinways sufficientto maintaintheir competence

e-resources	
1	https://powerintegrated.in/iit-eee-projects/

CO-PO/PSOMappingMatrix

	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO1
	C409.1					3								3		
	C409.2	3	3											3		
	C409.3			3	3										3	
	C409.4						3	3				3				
	C409.5								3	3						3
	C409.6										3					3
	C409.7												3			3
	Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**