Model Curriculum for Three/Four Year Degree Course (With Multiple Entry/Exit Option)

Based on NEP-2020

Physics

Odisha State Higher Education Council, Bhubaneswar

Government of Odisha

PhysicsBasket-1

Semester	FourYear Hons .WithoutResearch	FourYearHons. WithResearch	ThreeYearDegreecourse with singleMajor andTwoMinor	Three YearDegreecoursewithDouble Major	Three YearDegree courseswiththree Core withoutMajor
I	1. (MathematicalPhysics-1)	1. (MathematicalPhysics-1)	1. (MathematicalPhysics-1)	1. (MathematicalPhysics-1)	1. (Mathematical Physics-1)
II	2. (Mechanics)	2. (Mechanics)	2. (Mechanics)	2. (Mechanics)	2. (Mechanics)
III	3. (ElectricityandMagnetism)	3. (ElectricityandMagnetism)	3. (Electricityand Magnetism)	3. (ElectricityandMagnetism)	3.Quantum mechanicsand applications
	4.(Mathematical-Physics-2)	4.(Mathematical-Physics-2)	4.(Mathematical-Physics-2)	4. (Mathematical-Physics-2)	4 .ElectricityandMagnetism
	5. (WaveandOptics)	5. (WaveandOptics)	5. (WaveandOptics)	5. (WaveandOptics)	
IV	6. (Mathematical-Physics-3)	6.(Mathematical-Physics-3)	6.(Mathematical-Physics-3)	6. (Mathematical-Physics-3)	5. Analog Electronic sSystem
	7. (ThermalPhysics)	7. (Thermal Physics)	7. (ThermalPhysics)	7. (ThermalPhysics)	6.WaveandOptics
	8. (Analog System)	8. (Analog System)	8. (Analog System)	8. (Analog System)	
V	9.Basic Instrumentation	9.Basic Instrumentation	9.Basic Instrumentation	9.Basic Instrumentation	7. SolidStatePhysics
	10.NuclearandParticlePhysics	10.Nuclear andParticlePhysics	10 .NuclearandParticlePhysics	10 .NuclearandParticlePhysics	
	11.Digital System	11.DigitalSystem	11.DigitalSystem	11.Digital System	
	12.Quantummechanicsand applications	12.Quantummechanics an dapplications	12.Quantummechanics an dapplications	12.Quantummechanicsand applications	

VI	13.Solidstate Physics	13.Solidstate Physics	13.Solidstate Physics	13.Solidstate Physics	
	14.Electro-magneticTheory	14.Electro-magneticTheory	14.Electro-magneticTheory	14.Electro-magneticTheory	
	15.Statistical	15.Statistical	15.Statistical	15.Statistical	

	Physics	Physics	Physics	Physics	
VII	16. MathematicalMethodsinPhysics	16.ClassicalMechanics			
	17.ClassicalMechanics				
	18.QuantumMechanics1	17. QuantumMechanics1			
	19. Computational Physics Lab	18.ComputationalPhysicsLab			
VIII	20.ClassicalElectrodynamics	19. ClassicalElectrodynamics			
	21.QuantumMechanics2	20.OpticsandModern PhysicsLab			
	22.Electronics				
	23.Opticsand Modern Physics Lab				
Total	23X4=92	20X4=80	15X4=60	15X4=60	7X4=28

PhysicsBasket-2

Subject	MultidisciplinaryBasket	SECBasket	VACBasket
Physics	1. NanomaterialsandApplications 2. Biophysics 3. Introduction toSpectroscopy	**3rdSemester(2Credit)** RenewableEnergyand EnergyHarvesting **4thSemester(3Credit)** 1. AppliedOpticsand Photonics. 2. IntroductiontoQuantum Informationand Computing 3.Astronomyandastrophysics	ComputationalMaterialsModelling

PROGRAMME:B.Sc.PHYSICS

ProgrammeOutcomes

PO1:

Acquireadequateknowledgeofthesubject**PO2:**

Craft a foundation for higher learning**PO3:**

Beinitiatedintothebasicsof research**PO4:**

Imbibesoundmoralandethicalvalues

PO5: Become consciousofenvironmentalandsocietalresponsibilities

PO6: Attainskillsforcommunicationandcareer

PO7: Learntotoleratediverseideasanddifferentpointsofview

PO8: Becomeempoweredtofacethechallengesofthechanginguniverse

PROGRAMME:B.Sc.PHYSICS

CourseOutcomes

1:Understandthebasicconceptsof methodologyofscienceandthefundamentalso fmechanics,propertiesofmatterandelectrodynamics,MathematicalPhysics.

2:Understand the theoretical basis of Mathematical Physics,quantum mechanics,relativisticphysics, nuclear physics, optics, spectroscopy, solid state physics, astrophysics, statisticalphysics,photonicsandthermodynamics

3: Understand and apply the concepts of electronics in the designing of different analog anddigital circuits

4:Understandthebasicsofcomputerprogrammingandnumericalanalysis

5:Applyandverifytheoreticalconceptsthroughlaboratoryexperiments

COURSESTRUCTUREOFUGPHYSICS

PHYSICS

HONOURSPAPERS:

Corecourse–15

papersMarksperpaper–100
Creditperpaper–4

Teaching hoursperpaper–45hoursfortheory and30 hoursforpractical

SEMESTER–I

CORE–I:PAPER-I

MATHEMATICAL PHYSICS-I:Credit-3

CO1

BasicunderstandingofDifferentialequationsandtheirsolutions,conceptualunderstandingofcalculus.

CO2 Basicunderstandingofvectorcalculusanditsdifferentiation.

CO3 Useofvectorcalculustounderstandvector integration.Diracdeltafunctionandits properties.CO4 Understandingoforthogonalcurvilinearcoordinatesanditsapplicationinvectordifferentiation.CO5 To Understandthebasicalgorithminapplication tofunctionalalgebraanderroranalysis.

UNIT-I

Calculus-I: Plottingoffunctions,Intuitiveideasofcontinuous,differentiablefunctionsandplottingof curves,Approximation:Taylorand binomialseries(statementsonly),FirstOrderDifferentialEquationsandIntegratingFactor,SecondOrderDifferentialequations:HomogeneousEquationswithconstantcoefficients,Wronskianandgeneralsolution,Statementof existenceand Uniqueness Theoremfor InitialValueProblems,ParticularIntegral.

Calculus-II: Calculusoffunctionsofmorethanonevariable:Partialderivatives,exactandinexactdifferentials.Integratingfactorwithsimpleillustration,ConstrainedMaximizationusingLagrangeMultipliers,

UNIT-II

Vectoralgebra: Recapitulationofvectors:Propertiesofvectorsunderrotations. Scalarproductand itsinvariance underrotations,Vectorproduct, Scalartripleproduct andtheir interpretation intermsofareaandvolumerespectively,ScalarandVectorfields.

VectorDifferentiation:

Directionalderivativesandnormalderivative,Gradientofascalarfieldanditsgeometricalinterpretation,Divergenceandcurlofavectorfield,Del andLaplacianoperators,Vectoridentities.

UNIT-III

VectorIntegration: OrdinaryIntegralsofVectors,Multipleintegrals,Jacobian,Notionofinfitesimalline,surfaceandvolumeelements,Line,surfaceandvolumeintegralsofVectorfields,Fluxofavectorfield,Gauss 'divergencetheorem,Green's andStokes Theorems andtheirapplications(no rigorousproofs)**DiracDeltafunctionanditsproperties:**DefinitionofDiracdeltafunction.RepresentationaslimitofaGaussianfunctionandrectangularfunction,PropertiesofDiracdeltafunction.

UNIT-IV

OrthogonalCurvilinearCoordinates: Orthogonal Curvilinear Coordinates, Derivation ofGradient, Divergence,CurlandLaplacianinCartesian,SphericalandCylindricalCoordinateSystems,Comparisonofvelocityandaccelerationincylindricalandsphericalcoordinatesystem.

TextBooks:

1. Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris(2013,7thEdn.,Elsevier)
2. AdvancedEngineeringMathematics,ErwinKreyszig(WileyIndia)

Referencebooks:

1. MathematicalPhysicsC.Harper(PrenticeHallIndia)
2. ComplexVariable:Schaum'sOutlines SeriesM.Spiegel(2ndEdition,Mc-GrawHillEducation)
3. Complexvariablesandapplications,J.W.BrownandR.V.Churchill
4. MathematicalPhysics,SatyaPrakash(SultanChand)
5. MathematicalPhysics,B.D.Gupta(4thedition,VikasPublication)
6. MathematicalPhysicsandSpecialRelativity,M.Das,P.K.JenaandB.K.Dash(SrikrishnaPrakashan)
7. MathematicalPhysics–H.K.Das,Dr.RamaVerma(S.ChandPublishing)
8. MathematicalPhysics,B.S.Rajput,(PragatiPrakashana

CORE–I:PAPER-I
LAB:Credit-1

TheaimofthisLabisnotjusttoteachcomputerprogrammingandnumericalanalysisbuttoemphasizeitsroleinsolvingproblemsinPhysics.

- Highlightstheuseofcomputationalmethodstosolvephysicalproblems
- Evaluationd•onenotontheprogrammingbutonthebasisofformulatingtheproblem
- Aimatteachingstudentstoconstructthecomputationalproblemtobesolved
- StudentscanuseanyoneoperatingsystemLinuxorMicrosoftWindows

Introduction and Overview: Computer architecture and organization, memoryandInput/output devices. Basics of scientific computing: Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence,Selection and Repetition, single and double precision arithmetic, underflow and overflow emphasize the importance ofmaking equations in terms of dimensionless variables, Iterative methods. Algorithm Errors and error Analysis: Truncationandroundofferrors,Absoluteandrelativeerrors,Floatingpointcomputations.SystematicandRandomErrors,PropagationofErrors,NormalLawofErrors,StandardandProbableError.

ReviewofCandC++Programming: IntroductiontoProgramming,constants, VariablesandFundamentalsdatatypes,operatorsandExpressions,I/Ostatements, scanfand printf, cinandcout,Manipulatorsfordataformat-ting, Controlstatements (decisionmaking and loopingstatements) (IfStatement,IfelseStatement,NestedIfstructure,ElseIfStatement,Ternaryoperator,GotoStatement. Switch Statement. Unconditional and Conditional Looping.While Loop.Do-WhileLoop.FOR Loop.BreakandContinueStatements.Nested Loops),Arrays(1Dand2D) and strings,userdefinedfunctions,StructuresandUnions,Ideaofclassesandobjects.

Programs: Sumandaverage of a list of numbers, largest of a givenlist of numbersand its location in thelist,sortingofnumbersinascendingdescendingorder,Binarysearch.

Randomnumbergeneration: Areaofcircle,areaofsquare,volumeofsphere,valueofπ.

ReferenceBooks:

1. IntroductiontoNumericalAnalysis,S.S.Sastry,5thEdn.,2012,PHILearningPvt.Ltd.
2. Schaum'sOutlineofProgrammingwithC++.J.Hubbard,2000,McGraw– HillPub.
3. Numerica lRecipesinC:TheArtofScientificComputing,W.H.Pressetal,3rdEdn.2007,CambridgeUniversityPress.
4. AfirstcourseinNumericalMethods,U.M.AscherandC.Greif,2012,PHILearning.
5. ElementaryNumericalAnalysis,K.E.Atkinson,3rdEdn.,2007,WileyIndiaEdition.
6. NumericalMethodsforScientistsandEngineers,R.W.Hamming,1973,CourierDoverPub.
7. AnIntroductiontocomputationalPhysics,T.Pang,2ndEdn.,2006,Cam-bridgeUniv.Press.

SEMESTER–II

CORE–I:PAPER-IIMECHANICS:Credit-3

CO-1 ToLearnthebasicconceptsofRigidbodydynamics,RadiusofGyration,Moment ofInertia,Non-InertialSystems

CO-2 ToUnderstandtheconceptofElasticity,FluidmotionandTypes ofVibration

CO-3

TounderstandtheconceptofNewtoniantheorythroughGravitation,Centralforcemotion,Keplar'slaws,GPS

CO-4 TolearntheconceptofSpecialtheory ofRelativity,Michelson-Morleyexperiment,Lorentztransformation,RelativisticDopplereffect.

CO-5 ApplythebasicconceptsofMechanicsinexperiments.

UNIT-I

RotationalDynamics: CentreofMass,MotionofCoM,CentreofMassandLaboratory frames,Angularmomentumofaparticleandsystemofparticles,Principleofconservationofangularmomentum,Rotationaboutafixedaxis,MomentofInertia, Perpendicular and Parallel AxisTheorems,RouthRule,Calculationof momentof inertiaforcylindricalandsphericalbodies,Kineticenergyofrotation,Euler'sEquationsof RigidBodymotion,Motioninvolvingbothtranslationandrotation.MomentofInertiaofaFlywheel.

Non-InertialSystems: Non-inertialframesandfictitiousforces,uniformlyrotatingframe,LawsofPhysicsinrotatingcoordinatesystems,Centrifugalforce,Coriolisforce.

UNIT-II

Oscillations:

Dampedoscillation.Equationofmotionandsolution(casesofoscillatory,criticallydampedandoverdamped)Forced oscillations:Transientandsteadystates;Resonance,sharpnessof resonance; powerdissipationandQualityFactor,BarPendulum,KatersPendulum

Elasticity : RelationbetweenElasticconstants,TwistingtorqueonaCylinderorWire,Bendingofbeams,Externalbendingmoment,Flexuralrigidity,Singleanddoublecantilever

FluidMotion: Kinematics of Moving Fluids: Poiseuilles Equation for Flow of a Liquid through a CapillaryTube,Surfacetension,Gravitywavesandripple

Viscosity: PoiseuillesEquationforFlowofaLiquidwithcorrections.

UNIT-IIIGravitationandCentralForceMotion: Lawofgravitation,Gravitationalpotentialenergy,

Inertial and gravitational mass, Potential and field due to spherical shell and solid sphere, Motion of a particleunderacentralforcefield,Two-body problemanditsreductiontoone-bodyproblemanditssolution,Differential Equationof motion withcentralforceanditssolution,Thefirst Integrals(two),ConceptofpowerLawPotentials,Kepler's LawsofPlanetarymotion,Satellites.Geosynchronousorbits ,Weightlessness,Basicideaofglobalpositioningsystem(GPS).

UNIT-IV

SpecialTheoryofRelativity: Michelson-MorleyExperimentanditsout-come,Postulatesof SpecialTheoryof Relativity,LorentzTransformations,Simultaneityandorderofevents,Lorentzcontraction,Timedilation,Relativistict ransformationofvelocity,Frequency and wave number, Relativisticadditionof velocities,Variationof masswithvelocity,MasslessParticles,Mass-energyEquivalence,RelativisticDopplereffect,RelativisticKinematics,TransformationofEnergyandMomentum.

TextBooks:

1. Mechanics,D.S.Mathur(S.ChandPublishing)
2. IntroductiontoSpecialRelativity,R.Resnick(JohnWiley)

ReferenceBooks:

1. IntroductiontoMechanicsDanielKlapnnerandRobertKolenkow,McgrawHill.
2. MechanicsbyK.RSimon
3. Mechanics,BerkeleyPhysics,vol.1,C.Kittel,W.Knight,etal(TataMcGraw-Hill)
4. Physics,Resnick,HallidayandWalker(8/e.2008,Wiley)
5. TheoreticalMechanics-M.R. Spiegel(TataMcGrawHill).
6. FeynmanLectures,Vol.I,R.P.Feynman,R.B.Leighton,M.Sands(Pearson)
7. Mechanics-M.Das,P.K.JenaandR.N.Mishra(SrikrishnaPublications)
8. ClassicalMechanics,GuptaKumar&Sharama,(PragatiPrakashan)
9. ClassicalMechanics,J.C.Upadhyaya,(HimalayaPublishingHome)

CORE–I:PAPER-II

LAB:Credit-1

(Minimum4experimentsaretobedone):

1. Tostudy surfacetensionbycapillaryrisemethod.
2. TodeterminetheheightofabuildingusingaSextant.
3. TostudytheMotionofSpringandcalculate(a)Springconstant,(b)gand(c)Modulusofrigidity.
4. TodeterminetheMomentofInertiaofaFlywheel.
5. TodetermineCoefficientof Viscosityof waterbyCapillaryFlowMethod(Poiseuillesmethod).
6. TodeterminetheModulusofRigidityofaWirebyMaxwell'sneedle.
7. TodeterminethevalueofgusingBarPendulum.
8. TodeterminethevalueofgusingKater'sPendulum.

ReferenceBooks:

1. Advanc e•dPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop,1971,AsiaPublishingHouse.
2. AdvancedlevelPhysicsPractical's,MichaelNelsonandJonM.Ogborn,4thEdition,reprinted1985 ,HeinemannEducationalPublishers.
3. AText B ookofPracticalPhysics,I.PrakashandRamakrishna,11thEdn,2011,KitabMahal.

SEMESTER–III

CORE–I:PAPER-III

ELECTRICITYANDMAGNETISM:Credit-3

CO-1 TounderstandthebasicconceptsofElectricityandMagnetism

CO-2 ToUnderstandthevariousphenomenainElectricityandMagnetismCO-

3 ToUnderstandCircuitanalysisandnetworktheorems

CO-4 ToExplaintheDynamicsofChargedParticlesCO-5

ToApplytheacquiredknowledgeinExperiment.

UNIT-1

ElectricFieldandElectricPotential

Electric field: Electric field lines, Electric flux, Gauss Law with applications to charge distributions withspherical, cylindrical and planar symmetry, Conservative nature of Electrostatic Field. Electrostatic Potential,PotentialandElectricFieldofadipole,ForceandTorqueonadipole,Potentialcalculationindifferent simplecases,LaplaceandPoissonequations,TheUniquenessTheorem,MethodofImagesan ditsapplicationto(1)PlaneInfiniteSheetand(2)Sphere.

Electrostaticenergyofsystemofcharges,Electrostaticenergyofachargedsphere,ConductorsinanelectrostaticFiel d,Surfacechargeandforceonaconductor.

UNIT-II

MagneticField: Magnetic Force,LorentzForce, BiotSavarts Law,Cur- rent Loop as a Magnetic Dipoleand its Dipole Moment (analogy with Electric Dipole), Amperes Circuital Law and its application to (1)Solenoid(2)Toroid(3) Helmhotzcoil,Propertiesofcurlanddivergence,VectorPotential,BallisticGalvanometer:TorqueonacurrentLoop,C urrentandChargeSensitivity,Electromagneticdamping,Logarithmicdamping,CDR.

UNIT-III

Dielectric Propertiesof Matter : ElectricFieldinmatter,Polarization,PolarizationCharges,ElectricalSusceptibilityandDielectricConstant,Capacito r(parallelplate,spherical,cylindrical)filledwithdielectric, Displacementvector D, Relations betweenE,Pand D,GaussLawindielectrics.MagneticPropertiesofMatter: Magnetizationvector(M),MagneticIntensity(H),MagneticSusceptibilityandpermeability,RelationbetweenB,H,M ,Ferromagnetism,B-Hcurveandhysteresis.ElectromagneticInduction: Faradays Law, Lenz’s Law, Self - Inductance and Mutual Inductance, Reciprocity Theorem, EnergystoredinaMagnetic Field,IntroductiontoMaxwell’sEquations.

UNIT-IV

ElectricalCircuits: AC Circuits: Kirchhoffs laws for ACcircuits,Complex Reactanceand Impedance,SeriesLCRCircuit:(1)Resonance(2)PowerDissipation(3)Quality Factor, (4)BandWidth,ParallelLCRCircuit.

Networktheorems: Kirchoff’slawforelectricalcircuits,IdealConstant-voltageandConstant-currentSources.

NetworkTheorems:Thevenintheorem,Nortontheorem,Superposition theorem,Reciprocitytheorem,MaximumPowerTransfertheorem,ApplicationstoDCcircuits.TransientCurr entsGrowthanddecayofcurrentinRCandLRcircuits.

TextBooks:

1. IntroductiontoElectrodynamics– D.J.Griffiths(Pearson,4thedition,2015)2.

FoundationsofElectromagneticTheory-RitzandMilford(Pearson)

ReferenceBooks:

1. ClassicalElectrodynamics,J.D.Jackson(Wiley).
2. ElectricityandMagnetismD.C.Tayal(HimalayaPublishinghouse)
3. Electricity,MagnetismandElectromagneticTheory- S.MahajanandChoudhury(TataMcGrawHill)
4. FeynmanLecturesVol.2,R.P.Feynman,R.B.Leighton,M.Sands(Pearson)
5. ElectricityandMagnetism,J.H.FewkesandJ.Yarwood.Vol.I(OxfordUniv.Press)
6. ClassicalElectromagnetism,H.C.Verma,BharatiBhawan

CORE–I:PAPER-III
LAB:Credit-1
(Minimumof6experimentsaretobedone)

UseaMultimeterformeasuring(a)Resistances,(b)ACandDCVoltages,c)DCCurrent, (d)Capacitances,and(e)Checkingelectricalfuses.

1. TostudythecharacteristicsofaseriesRCCircuit.
2. TodetermineanunknownLowResistanceusing Potentiometer.
3. TodetermineanunknownLowResistanceusingCareyFostersBridge.
4. TocomparecapacitancesusingDeSauty'sbridge.
5. MeasurementoffieldstrengthBanditsvariationinasolenoid(determinedB/dx)
6. Toverify theThevenin andNortontheorems.
7. Todetermineself-inductanceofacoilbyAndersons bridge.
8. TostudyresponsecurveofaSeriesLCRcircuitanddetermineits(a)Reso-nantfrequency, (b)Impedanceatresonance,(c)QualityfactorQ,and(d)Bandwidth.
9. TostudytheresponsecurveofaparallelLCRcircuitanddetermineits(a)
10. Anti-resonancefrequencyand(b)QualityfactorQ.

ReferenceBooks:

1. AdvancedPractical Physicsforstudents,B.L.Flintand H.T.Worsnop,1971,AsiaPublishingHouse
2. ATextBookofPracticalPhysics,I.PrakashandRamakrishna,11thEd.,2011,KitabMahal
3. AdvancedlevelPhysicsPracticals,MichaelNelsonandJonM.Ogborn,4thEdition,reprinted1985,HeinemannEducationalPublishers
4. ALaboratoryManualofPhysicsforundergraduateclasses,D.P.Khandelwal,1985,VaniPub.

CORE–I:PAPER-IVMATHEMATICALPHYSICS-II:Credit-3

Theemphasisofthecourseisonapplicationsinsolvingproblemsofinteresttophysicists.Studentsare tobeexaminedonthebasisofproblems,seenandunseen.

CO-1:Conceptual understanding ofFourierseriesanditsapplicationinperiodicfunction.CO-2:Understandingthe variousspecialfunctionsanditsproperties.

CO-3: Understandingvarious polynomials and special integrations.CO-4:Tolearntheapplicationsofpartialdifferentialequation.

CO-5:Toapplytheacquiredknowledgetosolveproblems.

UNIT-I

FourierSeries-I: Periodicfunctions,Orthogonalityof sineandcosinefunctions,DirichletConditions(Statementonly),Expansionofperiodicfunctionsinaseriesofsineandcosinefunctionsanddeterminationof Fouriercoefficients,Complexrepresentationof Fourierseries,Expansionof functionswitharbitrary period, Expansionof non-periodicfunctionsover aninterval, Evenandoddfunctionsandtheir FourierexpansionsandApplication,Summingof InfiniteSeries,Term-by-Termdifferentiationandintegrationof FourierSeries,ParsevalIdentity.

UNIT-II

FrobeniusMethodandSpecialFunctions: SingularPointsofSecondOrderLinearDifferentialEquations and their importance, Singularities of Bessel's and Laguerre Equations, Frobeniusmethodanditsapplicationstodifferentialequations:Bessel,LegendreandHermiteDifferential

Equations,LegendreandHermitePolynomials:Rodrigues Formula, G enerating Function,Orthogonality.

UNIT-III

Polynomials: Simple recurrence relationsofLegendreandHermitePolynomials, Expansionof functioninaseriesofLegendrePolynomials,AssociatedLegendreDifferentialEquation,AssociatedLegendrepolynomials,SphericalHarmonics.SphericalBessel'sFunction(1stand2ndkind).

SomeSpecialIntegrals: BetaandGammaFunctionsandrelationbetweenthem,Expression ofIntegralsintermsofGammaFunctions,ErrorFunction(ProbabilityIntegral).

UNIT-IV

PartialDifferentialEquations: Solutionstopartial differential equations using separation ofvariables:Laplace'sEquationinproblemsofrectangular,cylindricaland spherical symmetry.Conductinganddielectricsphereinanexternaluniformelectricfield.Waveequationanditssolutionforvibrationalmodesofastretchedstring.

TextBooks:

1. MathematicalMethodsforPhysicists,G.B.Arfken,H.J.Weber,F.E.Harris. (2013,7thEdn.,Elsevier)
2. AdvancedEngineeringMathematics,ErwinKreyszig(WileyIndia)

ReferenceBooks:

1. MathematicalPhysicsand SpecialRelativity,M.Das,P.K.Jena andB.K.Dash(SrikrishnaPrakashan)
2. MathematicalPhysics–H.K.Dass,Dr.RamaVerma(S.ChandPublishing)
3. MathematicalPhysicsC.Harper(PrenticeHallIndia)
4. ComplexVariable:Schaum'sOutlinesSeriesM.Spiegel(2ndEdition,McGrawHillEducation)
5. ComplexvariablesandapplicationsJ.W.BrownandR.V.Churchill
6. MathematicalPhysics,SatyaPrakash(SultanChand)
7. MathematicalPhysicsB.D.Gupta(4thedition,VikasPublication)
8. MathematicalPhysics,B.S.Rajput,PragatiPrakashan

CORE–I:PAPER-IV
LAB:Credit-1

TheaimofthisLabistousethecomputationalmethodstosolvephysicalproblems.Coursewillconsistof

lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis offormulatingtheproblem.

Topics

IntroductiontoNumericalcomputationsoftwareScilab

:IntroductiontoScilab,Advantagesanddisadvantages,Scilab computationsoftwareScilab environment,Command window, Figure window, Editwindow, Variables and arrays, Initialising variables inScilab, Multidimensional arrays,Subarray,Specialvalues,Displayingoutputdata,datafile,Scalarandarrayoperations,Hierarchyof operations,BuiltinScilabfunctions,Introductiontoplotting,2Dand3Dplotting(2),

BranchingStatements and program design, Relational and logical operators,the whileloop,forloop,detailsof loop operations, break and continuestatements, nested loops, logical arrays and vectorization (2) Userdefinedfunctions,IntroductiontoScilabfunctions,VariablepassinginScilab,optionalarguments,preserving data between calls to a function, Complex and Character data, string function, Multidimensionalarrays(2)anintroductiontoScilabfileprocessing,fileopeningandclosing,BinaryI/ ofunctions,comparingbinaryandformattedfunctions,Numericalmethodsanddevelopingtheskillsof writingaprogram(2).

Curvefitting,LeastsquarefitGoodnessoffit,standard constant Deviation: Ohms law tocalculateR,Hookeslawtocalculatespringconstant

SolutionofLinearsystemofequationsbyGausseliminationSolutionmethodandGaussSeidalmethod .Diagonalization matrices,Inverseofamatrix,Eigenvectors, problems: Solution ofmeshequationsofelectriccircuits(3meshes),Solutionofcoupled springmasssystems(3meshes).

SolutionofODEFirstorderDifferentialequationEuler,modiftedEulerRunge-KuttasecondmethodsSecondorderdifferentialequation.Fixeddifferencemethod:

Firstorderdiferentialequation

- Radioactivedecay
- CurrentinRC,LCcircuitswithDCsource
- Newtonslawofcooling
- Classicalequationsofmotion

Secondorder DifferentialEquation

- Harmonicoscillator(nofriction)
- DampedHarmonicoscillator

- Overdamped
- Criticaldamped
- Oscillatory
- ForcedHarmonicoscillator
- TransientandSteadystatesolution
- ApplyabovetoLCRcircuitsalso

ReferenceBooks:

1. MathematicalMethodsforPhysicsandEngineers,K.FRiley,M.P.Hobson andS. J.20Bence,3rded.,2006,CambridgeUniversityPress.
2. ComplexVariables,A.S.FokasandM.J.Ablowitz,8thEd.,2011, CambridgeUniv.Press.
3. Firstcourseincomplexanalysiswithapplications,D.G.ZillandP.D.Shana-han,1940,JonesandBartlett.
4. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB:ScientificandEngineeringApplications:A.V.Wouwer,P.Saucez,C.V.Fern-ndez.2014Springer.
5. Scilabbyexample:M.Affouf2012,ISBN:978-1479203444
6. Scilab (Afreesoftwareto Matlab):H.Ramchandran,A.S.Nair.2011S.ChandandCompany
7. ScilabImageProcessing:LambertM.Surhone.2010BetascriptPublishing

CORE–I:PAPER-
VWAVESANDOPTICS:Credit-3

CO-1:Basicunderstanding ofpropagation of light, its application and wave nature.CO-2:ToUnderstandtheconcepts ofwavemotion.
CO-3:To Understand the concepts of interference and its application.CO-4:To Understand the concepts of diffraction and its application.CO-5:ToApplytheacquiredknowledgeofoptics inExperiment

UNIT-I

Geometricaloptics:Fermat’sprinciple,reflectionandrefractionatplaneinterface,Matrixformulationof geometricalOptics,CardinalpointsandCardinalplanes ofan opticalsystem,Ideaofdispersion,

Application to thick Lens and thin Lens, Ramsden and Huygens eyepiece. Wave Optics :Electromagneticnature of light. Definition and properties of wave front Huygens Principle.Temporal and Spatial Coherence.**UNIT-II**

WaveMotion
:PlaneandSphericalWaves,LongitudinalandTransverseWaves,PlaneProgressive(Traveling)Waves,WaveEquation,ParticleandWaveVelocities,DifferentialEquation,Pressureof aLongitudinal Wave, Energy Trans- port, Intensityof Wave.Superpositionof two perpendicularHarmonicOscillations: Graphical and Analytical Methods, Lissajous Figures (1:1and1:2)andtheir uses,SuperpositionofHarmonicwaves.

UNIT-III

Interference: Divisionof amplitudeand wave front, Young's doubleslit experiment, Lloyds Mirror andFresnels Bi-prism, Phase change onreflection:Stokes treatment, Interference in Thin Films: parallel andwedge-shapedfilms,Fringesof equalinclination(HaidingerFringes),Fringes of equal thickness(FizeauFringes), Newton's Rings: Measurementof wavelengthand refractive index. Interferometer: Michelson'sInterferometer-(1)Ideaof formof fringes(Notheoryrequired),(2)Determinationof Wavelength,(3)WavelengthDifference, (4)RefractiveIndex,and(5)Visibilityoffringes,Fabry-Perotinterferometer.

UNIT-IV

Fraunhofferdiffraction: Singleslit,Circularaperture,ResolvingPowerofatelescope,Doubleslit,Multiple slits, Diffractiongrating, Resolving powerof grating. Fresnel Diffraction: Fresnel's Assumptions,Fresnel's Half-Period Zones for Plane Wave, Explanationof Rectilinear Propagation of Light, Theory of aZone Plate:Multiple Fociof a Zone Plate,Fresnel's Integral,Fresneldiffractionpatternof astraightedge,aslitandawire.

TextBooks:

1. AtextbookofOpticsN.SubhramanyamandBrijLal(S.Chand Publishing)
2. Optics-AjoyGhatak(McGrawHill)

ReferenceBooks:

1. Optics-E.Hecht(Pearson)
2. FundamentalsofOptics-F.A.JenkinsandH.E.White(McGraw-Hill)
3. GeometricalandPhysicalOptics R.S.Longhurst(OrientBlackswan)
4. ThePhysicsofVibrationsandWaves-H.J.Pain(JohnWiley)

5. OpticsP.K.Chakraborty.
6. PrinciplesofOptics-MaxBornandEmilWolf(PergamonPress)
7. ThePhysicsofWavesandOscillations-N.K.Bajaj(McGrawHill)

CORE–I:PAPER-V

LAB:Credit-1

(Minimum5experimentsaretobedone)

1. Todeterminethefrequencyofanelectrictuningforkby Melde'sexperimentandverify2-Tlaw.
2. ToplottheI-Dcurveandtodeterminetherefractiveindexofaprism
3. TodeterminerefractiveindexoftheMaterialofaprismusingsodiumsource.
4. TodeterminethedispersivepowerandCauchyconstantsofthematerialofaprismusingmercurysource.
5. TodeterminewavelengthofsodiumlightusingNewton'sRings.
6. Todeterminewavelengthof(1)Nasourceand(2)spectrallinesofHgsourceusingplanediffractiongrating.
7. Todeterminedispersivepowerandresolvingpowerofaplanediffractiongrating.
8. *ReferenceBooks:*

1. AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop,1971,AsiaPublishingHouse
2. ATextBookofPracticalPhysics,I.PrakashandRamakrishna,11thEd.,2011,KitabMahal
3. AdvancedlevelPhysicsPracticals,MichaelNelsonandJonM.Ogborn,4thEdition,reprinted1985,HeinemannEducationalPublishers
4. ALaboratoryManualofPhysicsforundergraduateclasses,D.P.Khandelwal,1985,Vani

SEMESTER–IV

CORE–I:PAPER-VIMATHEMATICALPHYSICS-III:Credit-3

CO-1:UnderstandingandapplicationofComplexfunctionvariables.

CO-2:UnderstandingtheconceptofFourier Integraltransform.

CO-3:To Understand the properties and application of Fourier integral transformation.

CO-4:ToUnderstandthepropertiesandapplicationofLaplaceintegraltransformation.

CO-5:ToApplytheacquiredknowledgetosolveproblems.

UNIT-I

ComplexAnalysis: BriefRevisionofComplexNumbersandtheirGraphicalRepresentationEuler's formula,DeMoivrestheorem,Rootsof complexNumbers, Functionsof ComplexVariables, AnalyticityandCauchy-RiemannConditions,Examplesof analyticfunctions,Singularfunctions:polesandbranchpoints,orderofsingularity,branchcuts,Integrationofafunction ofacomplexvariable,CauchysInequality,CauchysIntegralformula,Simplyandmultiplyconnectedregion,Laurentan dTaylorsexpansion,ResiduesandResidueTheorem,ApplicationinsolvingDefiniteIntegrals.

UNIT-II

IntegralTransforms-I: FourierTransforms:FourierIntegraltheorem,FourierTransform,Examples,FourierTransformof trigonometric,Gaussian,finitewavetrainandotherfunctions,RepresentationofDiracdeltafunctionasaFourierIntegral ,Fouriertransformofderivatives,InverseFourierTransform.

UNIT-III

IntegralTransforms-II: Convolutiontheorem,Propertiesof Fourier Trans- forms (translation,changeofscale,complexconjugation),ThreedimensionalFouriertransformswith examples,Applicationof FourierTransformstodifferentialequations:OnedimensionalWaveandDiffusion/ HeatflowEquations.

UNIT-IV

LaplaceTransforms: LaplaceTransforms(LT)ofElementaryfunctions,

Properties of Laplace Transforms: Change of Scale Theorem, Shifting Theorem, LTs of Derivatives andIntegrals of Functions, Derivatives and Integralsof Functions, Derivativesand Integrals of LTs. LTof UnitStep function, Dirac Delta function, Periodic Functions, Inverse LT, Application of Laplace Transforms toDifferentialEquations:DampedHarmonicOscillator,SimpleElectricalCircuits.

TextBooks:

1. Mathematical Methods for Physicists, G.B.Arfken, H.J.Weber, F.E.Harris(2013,7thEdn.,Elsevier)
2. AdvancedEngineeringMathematics,ErwinKreyszig(WileyIndia)

ReferenceBooks:

1. MathematicalPhysicsandSpecialRelativity–M.Das,P.K.JenaandB.K.Dash(SrikrishnaPrakashan)
2. MathematicalPhysics–H.K.Dass,Dr.RamaVerma(S.ChandPublishing)

   MathematicalPhysicsC.Harper(PrenticeHallIndia)
3. Complex•Variable:Schaum'sOutlinesSeriesM.Spiegel(2ndEdition,Mc-GrawHillEducation)
4. ComplexvariablesandapplicationsJ.W.BrownandR.V.Churchill
5. MathematicalPhysics,SatyaPrakash(SultanChand)
6. MathematicalPhysicsB.D.Gupta(4thedition,VikasPublication)
7. MathematicalPhysicsB.S.Rajput,PragatiPrakashan
8. Mathematicalphysics-III,
   (UniversityPhysics),Dr.RanjanKumarBhuyan,HimalayaPublishingHouse

CORE–I:PAPER-VI

LAB:Credit-1

Scilabbasedsimulations(XCos)experimentsbasedonMathematicalPhysicsproblemslike

. Solvesimpledifferentialequationslike:

$$\frac{dy}{dx} = e^{-x} \quad \text{with} \; y(x=0)=0$$

$$\frac{dy}{dx} + e^{-x} = x^2 \quad \text{with} \; y(x=0)=0$$

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} = -y \quad \text{with} \; y(x=0)=0, y'(x=0)=1$$

$$\frac{d^2y}{dx^2} + e^{-x}\frac{dy}{dx} = -y \quad \text{with} \; y(x=0)=0, y'(x=0)=1$$

. DirectDeltaFunction:

Evaluate$\int_{-3}^{3} dx \frac{x=3}{\sqrt{2\pi a^2}} e^{-\frac{(x-2)^2}{2\sigma^2}}$,forσ=0.1,0.01,0.001andshowthatittendsto5.

. FourierSeries:

Programtosum;evaluatetheFourierCoefficientsofagivenperiodicfunction (SquareWave)

- FrobeniusMethodandSpecialFunctions:

$$\int_{-1}^{1} d\mu \ P_n\mu \, P_m\mu = \frac{2}{2n+1}\delta_{m,n}$$

Plot

$P_n(x)$,Legendrepolynomialofdegreen,and$J_n(x)$,Besselfunctionoffirstkind.ShowRecursion relation.

-

Calculationoferrorforeachdatapointofobservationsrecordedinexperimentsdoneinprevioussemesters(chooseanytwo)

-

Calculationofleastsquarefittingmanuallywithoutgivingweightagetoerror.Confirmationofleastsquarefittingofdatathroughcomputer Programme.

- Evaluationof trigonometricfunctionse.g.SinΘ,GivenBessel'sfunctionat N points,find itsvalueatanintermediatepoint.

Complexanalysis:Calculate $\int \frac{dx}{x^2+2}$ andcheckitwithcomputerintegration.

- Integraltransform:FFTof e^{-x^2}

ReferenceBooks:

1. Mathematical Methods for Physics and Engineers, K. FRiley, M.P. Hobsonand S. J.Bence,3rded.,2006,CambridgeUniversityPress.
2. MathematicsforPhysicists,P.DenneryandA.Krzywicki,1967,DoverPublications.
3. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientificand Engineering Applications: A. Vande Wouwer, P.Saucez, C.V. Fernndez. 2014SpringerISBN:978-3319067896
4. Scilabbyexample:M.Affouf,2012.ISBN:978-1479203444
5. Sc ilab(AfreesoftwaretoMatlab):H.Ramchandran,A.S.Nair.2011S.ChandAndCompany,ScilabImageProcessing:LambertM.Surhone.2010 BetascriptPublishing.

CORE–I:PAPER-

VIITHERMALPHYSICS:Credit-

3

CO-1:Basicunderstandingofthermodynamics andvariousthermalvariables.

CO-

2:Understandingvariousthermodynamicspotentialapplicationsandtheirproperties.CO-

3:ToUnderstandtheconceptsofidealgasandits thermalproperties.

CO-4:To Understand the concepts ofreal gas and its thermal properties.CO-

5:ToApplytheacquiredknowledgeofthermodynamicsinExperiments

UNIT-I

Introduction toThermodynamics RecapitulationofZerothandFirstlawofthermodynamics,

SecondLawof Thermodynamics: ReversibleandIrreversibleprocesswithexamples, Kelvin-PlanckandClausiusStatements and their Equivalence,Carnot's Theorem,Applications

ofSecondLawofThermodynamics:ThermodynamicScaleofTemperatureanditsEquivalencetoPerfectGasScale.

Entropy: Conceptof Entropy,ClausiusTheorem.Clausius Inequality,Second Lawof Thermodynamicsin terms ofEntropy, Entropy ofa perfect gas, Principle of increaseof Entropy,EntropyChangesinReversibleandIrreversibleprocesseswithexamples,Entropyof thePrinciple ofIncrease ofEntropy,TemperatureEntropydiagramsforCarnot'sCycle,ThirdLawofThermodynamics,UnattainabilityofAbsoluteZero.

UNIT-II

ThermodynamicPotentials: ExtensiveandIntensiveThermodynamicVariables. Internal Energy,Enthalpy,HelmholtzFreeEnergy,GibbsFreeEnergy,TheirDefinitions,PropertiesandApplications,SurfaceFilmsand Variationof SurfaceTension withTemperature, MagneticWork, Coolingduetoadiabaticdemagnetization.

PhaseTransitions

:FirstandsecondorderPhaseTransitionswithexamples,ClausiusClapeyronEquationandEhrenfestequations.

MaxwellsThermodynamicRelations: Derivations andapplications of Maxwells Relations, MaxwellsRelations: (1)ClausiusClapeyronequation(2)RelationbetweenC_{p}andC_{v}(3)TdSEquations,(4)Joule-

Kelvincoefficientfor Idealand. VanderWaalGases(5)Energyequations(6)Changeof TemperatureduringAdiabaticProcess.

UNIT-III

KineticTheoryofGases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and itsExperimental Verification, SternsExperiment,Mean,RMSandMostProbableSpeeds,DegreesofFreedom,LawofEquipartitionofEnergy(Nopro ofrequired),SpecificheatsofGases.

MolecularCollisions: MeanFreePath,CollisionProbability,EstimatesofMeanFreePath,

TransportPhenomenoninIdealGases:(1)Viscosity, (2)ThermalConductivityand(3)Diffusion.BrownianMotionanditsSignificance.

UNIT-IV

RealGases: BehaviorofRealGases:DeviationsfromtheIdealGasEquation,TheVirialEquation,Andrews ExperimentsonCO2Gas.CriticalConstants,Continuityof LiquidandGaseousState.Vapourand Gas, Boyle Temperature, Van derWaals Equationof State for RealGases, Values of Critical Constants,Lawof CorrespondingStates,Comparison withExperimentalCurves,P-VDiagrams,JoulesExperiment,FreeAdiabaticExpansionof aPerfectGas,Joule-ThomsonPorousPlugExperiment,Joule-ThomsonEffectforRealandVanderWaalGases,TemperatureofInversion,Joule-ThomsonCooling.

TextBooks:

1. ThermalPhysics,A.B.Gupta(BooksandalliedLtd)
2. HeatandThermodynamics,M.W.Zemansky,RichardDittman(McGraw-Hill)

ReferenceBooks:

1. TheoryandexperimentsonthermalPhysics,P.K.Chakrabarty(Newcen-tralbookagencylimited)
2. Thermodynamics,KineticTheoryandStatisticalThermodynamics-SearsandSalinger(Narosa)
3. ATreatiseonHeat-MeghnadSahaandB.N.Srivastava(TheIndianPress)Heat,andthermodynamicsandStatisticalPhysics,N.SubrahmanyamandBrijLal

   (S.ChandPublishing)

4. ThermalandStatisticalPhysicsM.Das,P.K.Jena,S.Mishra,R.N.Mishra(ShriKrishnaPublication)
5. Heat, Thermodynamics and statistical physics, Brijlal, Subhramanyam andHemne,S.ChandPublication.

CORE–I:PAPER-VII

LAB:Credit-1

(Minimum5experimentsaretobedone)

1. TodetermineMechanicalEquivalentofHeat,J,byCallenderandBarnesconstant flowmethod.
2. TodeterminetheCoefficientofThermalConductivityof abadconductorbyLeeandCharltonsdiscmethod.
3. TodeterminetheTemperatureCoefficientofResistancebyPlatinumResistanceThermometer(PRT).
4. T ostudythevariationofThermo-EmfofaThermocouplewithDifferenceofTemperatureofitsTwoJunctions.
5. TodetermineJbyCaloriemeter.
6. Todeterminethespecificheatofliquidbythemethodofcooling.
7. Todeterminethespecificheatofsolidbyapplyingradiationofcorrection.

ReferenceBooks:

1. AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop,1971,AsiaPublishingHouse
2. ATextBookofPracticalPhysics,I.PrakashandRamakrishna,11thEd.,2011,KitabMahal
3. AdvancedlevelPhysicsPracticals,MichaelNelsonandJonM.Ogborn,4thEdition,reprinted1985,HeinemannEducationalPublishers
4. ALaboratoryManualofPhysicsforundergraduateclasses,D.P.Khandelwal,1985,VaniPub.

CORE–I:PAPER-VIII

ANALOGSYSTEMS:Credit-3

CO-1:Basicunderstandingofsemiconductordiodes,devicesandtheirapplications.CO-2 :To Understandthebasicconceptsintransistorsandamplifiers.
CO-3:ToUnderstandtheconceptofcoupledamplifieranditsapplicationinfeedbackcircuit.CO-4:To Understand theconceptsofoperationalamplifieranditsapplication.
CO-5:ToApplytheacquiredknowledgeofelectroniccircuitsinExperiments.

UNIT-1

Semiconductor Diodes: P and N typesemiconductors,energy leveldiagram,conductivity and Mobility,Conceptof Drift velocity, PN junction fabrication (simple idea), Barrierformation in PN Junction Diode,StaticandDynamicResistance,CurrentflowmechanisminForwardandReverseBiasedDiode,Driftvelocity,derivationforBarrierPotential,BarrierWidthandcurrentStepJunction.

Two terminaldeviceandtheirapplications:(1)Rectifier Diode: Half-waveRectifiers.center-tappedandbridgetypeFull-waveRectifiers,Calculation of Ripple Factor and RectificationEfficiency,LandCFilters(2)ZenerDiodeandVoltageRegulation,PrincipleandstructureofLEDS, (2) Photodiode(3)SolarCell.

UNITII

BipolarJunctionTransistors:n-p-nandp-n-ptransistors,Characteristicsof CB,CEandCCConfigurations,Currentgainsaand b,Relation betweenaand b,Load lineanalysisof Transistors, DCLoadlineandQ-point,Physicalmechanismofcurrentflow,Active,Cut-offandSaturationRegions.

Transistors Biasing: TransistorBiasingandStabilizationcircuits,FixedBias andVoltageDividerBias.

Amplifiers: Transistorsas 2-port network h-parameter EquivalentCircuit, Analysis of a singlestageCEamplifierusingHybridModel,InputandOutputimpedance,Current,VoltageandPowerGains.

UNIT-III

ClassificationofclassA,Band Camplifiers,Push-pullamplifier(classB).

CoupledAmplifier:RC-coupledamplifieranditsfrequencyresponse.

FeedbackinAmplifiers: Effectof PositiveandNegativeFeedbackonIn-putImpedance,OutputImpedance,GainStability,DistortionandNoise.SinusoidalOscillations:Barkhausenscriterian forselfsustainedoscillations.RCPhaseshiftoscillator,determinationofFrequency,HartleyandColpittsoscillators.

UNIT-IV

OperationalAmplifiers(BlackBoxapproach): CharacteristicsofanIdealandPracticalOP-AMP(IC741).Open-loopandClosedloopGain.FrequencyResponse.CMRR,SlewRateandconceptofvirtualground.

ApplicationsofOp-Amps:(1)Invertingandnon-invertingamplifiers(2)Adder(3)Subtractor(4)Differentiator,(5)Integrator(6)Logamplifier,(7)Zerocrossingdetector(8)Weinbridgeoscillator.

TextBooks:

1. FoundationsofElectronics-RaskhitandChattopadhyay(NewageInternationalPublication)
2. ConceptofElectronics-D.C.Tayal(HimalayPublication)

ReferenceBooks:

1. ElectronicdevicesandcircuitsR.L.Boylstad(PearsonIndia)
2. ElectronicPrinciples-A.P.Malvino(TataMcGrawHill)
3. PrinciplesofElectronics-V.K.MehtaandRohitMehta(S.ChandPub-lication)
4. OP-AmpsandLinearIntegratedCircuit-R. A.Gayakwad(PrenticeHall)
5. PhysicsofSemiconductordevices,DonaldANeamen(PrenticeHall)
6. AnalogSystemandApplication:GuptaKumar,PragatiPrakashan

CORE–I:PAPER-VIII

LAB:Credit-1

(Minimum5experimentsaretobedone)

1. TostudytheV-IcharacteristicsofaZenerdiodeanditsuseasvoltageregulator.
2. StudyofV-Iandpowercurvesofsolarcells,andfindmaximumpowerpointandefficiency.
3. TostudythecharacteristicsofaBipolarJunctionTransistorinCEconfiguration.
4. TostudythevariousbiasingconfigurationsofBJTfornormalclassAoperation.
5. To studythe frequencyresponse ofvoltagegain ofaRC-coupledtransistoramplifier.
6. TodesignaWienbridgeoscillatorforgivenfrequencyusinganon-amp.
7. TodesignaphaseshiftoscillatorofgivenspecificationsusingBJT.
8. TostudytheColpitt'soscillator.

ReferenceBooks:

1. ModernDigitalElectronics,R.P.Jain,4thEdition,2010,TataMcGrawHill.
2. BasicElectronics:Atextlabmanual,P.B.Zbar,A.P.Malvino,M.A.Miller,1994,McGrawHill.
3. Microprocessor Architecture Programming and applications with 8085, R.S.Goankar,2002,PrenticeHall.
4. Microprocessor8085: Architecture,Programming andinterfacing,A.Wadhwa,2010,PHILearning.

SEMESTER–V

CORE–I:PAPER-IX

BasicInstrumentation:Credit-3

CO-1:Conceptualunderstanding ofdifferentmeasurementofelectroniccircuit withmeasuringdevices.CO-2:BasicunderstandingofCROanditsapplications.

CO-3:Basicunderstandingofsignalgeneratorsanditsanalysis

CO-4.:Basicunderstandingofdigitalinstrumentsand their applications.

CO-5:ToApplythe acquiredknowledge ofdifferent electronicmeasurement-based instrumentsinExperiments

UNIT-I

BasicofMeasurement

:Instrumentsaccuracy,precision,sensitivity,resolutionrangeetc.Errorsinmeasurementsandloadingeffects.

Multimeter: Principles of measurement of dc voltage and dc current, ac volt- age, ac current and resistance.Specificationsofamultimeterandtheirsignificance.

ElectronicVoltmeter: Advantage over conventional multimeter for voltage measurement withrespect to input impedance and sensitivity. Principles of voltage,measurement(blockdiagramonly).SpecificationsofanelectronicVoltmeter/ Multimeterandtheirsignificance.

ACmillivoltmeter: Typeof ACmillivoltmeters:Amplifier-rectifier,andrectifier-amplifier.Blockdiagramacmillivoltmeter,specificationsandtheirsignificance.

UNIT-II

CathodeRayOscilloscope:BlockdiagramofbasicCRO.ConstructionofCRT,Electrongun,electrostatic focusingandacceleration(Explanationonly no mathematical treatment), brief discussion onscreenphosphor,visualpersistenceandchemicalcomposition.Timebaseoperation,synchronization.Frontpanelcontrols.SpecificationsofaCROandtheirsignificance.

ApplicationsofCRO:(1)Studyof WaveForm, (2)MeasurementofVoltage,Current,FrequencyandPhaseDifference.

Specialfeaturesof dualtrace,introductiontodigitaloscilloscope,probes.DigitalstorageOscilloscope:Blockdiagramandprincipleofworking.

UNIT-III

SignalGeneratorsandAnalysisInstruments: Blockdiagram,explanationandspecificationsoflowfrequencysignal generators, pulse generator, and function generator, Brief idea for testing, specifications,Distortionfactormeter,waveanalysis.

UNIT-IV

DigitalInstruments : Principleandworkingofdigitalmeters,Comparisonofanaloganddigitalinstruments,Characteristicsofadigitalmeter, Workingprinciplesofdigitalvoltmeter.

DigitalMultimeter: Blockdiagramand workingofadigitalmultimeter,Working principleoftimeinterval,frequencyandperiodmeasurementusinguniversalcounter/frequencycounter, time-basestability,accuracyandresolution.

CORE–I:PAPER-IX
LAB:Credit-1

Thetestoflabskillswillbeofthefollowingtestitems:

1. Useofanoscilloscope.
2. CROasaversatilemeasuringdevice.
3. CircuittracingofLaboratoryelectronicequipment.
4. UseofDigitalmultimeter/VTVMformeasuringvoltages.
5. CircuittracingofLaboratoryelectronicequipment.
6. Windingacoil/transformer.
7. Studythelayoutofreceivercircuit.
8. Troubleshootingacircuit.
9. Balancingofbridges.

LaboratoryExercises:

1. Toobservetheloadingeffectofamultimeterwhilemeasuringvoltageacrossalowresistanceand highresistance.

2. Toobservethelimitationsofamultimeterformeasuringhighfrequencyvoltageandcurrents.
3. TomeasureQofacoilanditsdependenceonfrequency,usingaQ-meter.
4. Measurementofvoltage,frequency,timeperiodandphaseangleusingCRO.
5. Measurementoftimeperiod,frequency,averageperiodusinguniversalcounter/ frequencycounter.
6. Measurementofrise,fallanddelaytimesusingaCRO.
7. MeasurementofdistortionofaRFsignalgeneratorusingdistortionfactor meter.
8. MeasurementofR,LandCusingaLCRbridge/universalbridge.

OpenEndedExperiments:

1. UsingaDualTraceOscilloscope
2. Convertingtherangeofagivenmeasuringinstrument(voltmeter,ammeter)Moreemphasisshouldbegivenonhands-onexperiments.

TextBooks:

1. ATextBooksbookofelectricaltechnology-B.L.Theraja(S.ChandPublishing)
2. DigitalcircuitsandsystemsVenugopal(TataMcGrawHill)

ReferenceBooks:

1. DigitalElectronics-SubrataGhoshal(CengageLearning)
2. ElectronicDevicesandcircuits-S.SalivahananandN.S.Kumar(TataMc-GrawHill)
3. ElectronicDevices-ThomasL.Floyd(Pearson)

AdditionalReferenceBooksforPracticalpapers:

1. AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop(AsiaPublishingHouse)
2. Practical Physics-B.B.Swain (KitabMahal)
3. PracticalPhysics-B.Ghosh(Vol.IandII)
4. A Laboratory Manual of Physics forUndergraduateClasses,D.P.Khandelwal(VaniPublication)
5. B.Sc.PracticalPhysics-C.L.Arora(S.ChandPublishing)
6. B.Sc.PracticalPhysicsH.SinghandP.S.Hemne(S.ChandPublishing)

CORE–I:PAPER-X

NuclearandParticlePhysics:Credit-3

CO-1:Understandingthepropertiesofatomsinelectricandmagneticfield.CO-2:UnderstandingtheconceptNuclearphysics.

CO-3:Conceptualunderstandingnuclearmodelsandnuclearreactions.CO-4:Conceptualunderstandingofparticlephysics.

CO-5:ToApplytheacquiredknowledgeinconductingtheexperiments.

UNIT-I

AtomsinElectricandMagneticFields: Electronangularmomentum.Spacequantization, ElectronSpinandSpinAngularMomentum,Larmor's Theorem,SpinMagnetic Moment,Stern GerlachExperiment,VectorAtomModel,L-SandJ-Jcoupling,ZeemanEffect,ElectronMagnetic Momentand Magnetic Energy,Gyromagnetic Ratio and BohrMagnetron.Atoms in External Magnetic Fields:NormalandAnomalousZeemanEffect,PaschenbackandStark-Effect(qualitativeDiscussiononly).

UNIT-II

Nuclear Physics- : Nuclear composition, charge, size, shape, mass and density of the nucleus; Nuclearangularmomentum;Nuclearmagneticdipolemoment;Electricquadrupole moment; Massdefect;Packing fraction and Binding energy; Stability of nuclei (N vs Z curve), Binding e nergy curve.semiempiricalmassformula;NuclearForces:Generalconceptofnuclearforce; Yukawa Meson fieldtheoryofnuclearforces;PropertiesofNuclearforces.

Radioactivedisintegration;Propertiesofalpha,beta,gammarays;lawofradioactive decay ;successiveradioactivedecay;radioactiveequilibrium;Radioisotopes;applicationofradioactivity(Agriculture,Medicinal,IndustrialandArchaeological).

UNIT-III

Nuclear models: Liquid Drop model; Shell model;magic numberin the nucleus; Alpha decay: Alphaparticlesspectra;Gamow'stheoryofAlphadecay;Betadecay:Shape ofBetarayspectrum;Explanation of Beta decay on the basis of Neutrino and Antineutrino hypothesis; Fermitheory of Betadecay;Selectionrules;Gammarayemission,

Nuclearreactions: KindsofNuclearreactions; Nuclearreactionkinematics; Q -value;CompoundNucleus and concept of direct reactions; Conservation laws; Nuclear reaction cross - sections. Nuclearenergy:NuclearFission;ChainreactionandCriticalMass;NuclearReactors an ditsbasiccomponents;NuclearFusion;ConditionforthemaintainedFusionreactions; Energyproduction instars;FusionreactioninSun,Principleofatomicbombandhydrogenbomb.

UNIT-IV

ParticlePhysics

Classification ofparticles-antiparticles andtheirinteractions; Conservation laws;Charges;Isospin;Baryonnumber;Leptonnumber;Strangeness; Hypercharge;Parity;Chargeconjugation; CPTtheorem;Conservation laws;Quarkasthebuildingblocksofhadrons; QuarkModel;Colou rdegreeoffreedom,SymmetryClassificationofelementaryparticles;HiggsBosonParticle(Godparticle),elementar yideaonLargeHadroncollider(LHC),Thefutureofuniverse,Darkmatteranddarkenergy.

TextBooks:

1. ConceptsofModernPhysicsArthurBeiser(McGrawHill)
2. ModernPhysicsMurugeshanandSivaprasad(S.Chand)
3. CohenB.L.,"ConceptsofNuclearPhysics",McGrawHillEducation.
4. TayalD.C.,"NuclearPhysics",HimalayaPublishingHouse.
5. Patel S.B.,"Nuclear Physics: AnIntroduction", NewAgeInternationalPublishers.
6. SinghJahan,"FundamentalofNuclearPhysics",PragatiPublications

ReferenceBooks:

1. QuantumMechanics:TheoryandApplications,A.K.GhatakandS.Lokanathan, (Macmillan)
2. IntroductiontoQuantumTheory,DavidPark(DoverPublications)
3. TheoryandProblemsofModernPhysics,Schaum'soutline,R.GautreauandW.Savin -(TataMcGraw-Hill)
4. ModernPhysics-Serway(CENGAGELearnings)
5. PhysicsofAtomsandMoleculesBransdenandJoachim(PearsonIndia)
6. AtomicandNuclearPhysics-A.B.Gupta(NewCentral)
7. TheoreticalNuclearPhysics,J.M.BlattandV.F.Weisskopf(Springer)

CORE–I:PAPER-X

LAB:Credit-1

(Minimum4experimentsaretobedone)

1. Studyofphotoelectriceffect.
2. Basicsof GMcountercharacteristicsandcountingstatistics.
3. StudyofGammarayspectroscopybySCAandMCA.
4. TodeterminethePlanck'sconstantusingLEDsofatleast4differentcolours.
5. Todeterminethevalueofe/mby(a)Magneticfocusingor(b)Barmagnet.

6. TosetuptheMillikanoildropapparatusanddeterminethechargeofanelectron.

ReferenceBooks:

1. Advanced PracticalPhysicsforstudents,B.L.Flintand H.T.Worsnop,1971,AsiaPublishingHouse
2. AdvancedlevelPhysicsPracticals,MichaelNelsonandJonM.Ogborn,4thEdition,reprinted1985,HeinemannEducationalPublishers
3. ATextBooksBookofPracticalPhysics,I.PrakashandRamakrishna,11thEdn ,2011,KitabMahal

CORE–I:PAPER-XI

DIGITALSYSTEMS:Credit-3

CO-1:ToUnderstandIC's andscales ofIntegration,DigitalCircuitsandtheirrealization,Applications

CO-2:BuildstrongknowledgeaboutBooleanAlgebra,Truthtables,EquivalentCircuits,Theoryandapplicationof CRO.

CO-3:GainaclearunderstandingofDataprocessingcircuits,ArithmeticCircuits,differenttypesofTimers:IC555

CO-4: To Explain the knowledge of computer organization, Shift registers and counters.CO-5: ToApplythe acquired knowledgeto realizevarioustypesofcircuitsinexperiment

UNIT-1

Integrated Circuits (Qualitative treatment only): Active and Passive Components, Discrete components,Wafer Chip, Advantagesand Drawbacks of ICs,Scaleof Integration:SSI, MSI, LSI and VLSI(basic ideaanddefinitionsonly),ClassificationofICs,ExamplesofLinearandDigitalICs.

DigitalCircuits: DifferencebetweenAnalogandDigitalCircuits, Binary Numbers, Decimal toBinaryandBinarytoDecimalConversation,BCD,OctalandHexadecimalnumbers,AND,ORandNOT.Gates(realizationusingDiodesandTransistor),NANDandNORGates asUniversalGates,XORandXNORGatesandapplicationasParityCheckers.

UNIT-II

Boolean algebra: De Morgan's Theorems: Boolean Laws,Simplification of LogicCircuit using BooleanAlgebra, Fundamental Products,Ideaof Mintermsand Maxterms,Conversion of truth table into KarnaughMapandSOPandPOSsimplification.Universallogicimplementation(NAND&NOR).

UNIT-III

DataProcessingCircuits: BasicIdeaofMultiplexers,De-multiplexers,Decoders,Encoders.

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2s complement. Half and Full Adders.HalfandFullSubtractors,4bitbinaryAdder/Subtractor.

Timers: IC 555: block diagram and application is Astable multivibrator and Monostablemultivibrator.

UNIT-IV

IntroductiontoComputerOrganization: Input/outputDevices,Datastorage(ideaofRAM andROM),Computermemory,Memoryorganizationandaddressing,MemoryInterfacing,MemoryMap.

Shift registers: Serial-in-serial-out, Serial-in-Parallel-out,Parallel-in-Serial- out and Parallel-in-Parallel-out.ShiftRegisters(onlyupto4bits)

Counters(4bits): RingCounter,Asynchronouscounters,DecadeCounter.SynchronousCounter.

TextBooks:

1. DigitalCircuitsandLogicdesign:SamuelC.Lee(PrinticeHall)
2. DigitalPrinciples andApplications - A.P. Malvino,D.P.Leach and Saha(TataMcGraw)

ReferenceBooks:

1. The Art of Electronics by Paul Horowitz and Wilfield Hill ,CambridgeUniversity
2. ElectronicsbyAllanR. Hambley ,PrenticeHall 3. Principles ofElectronicsV.K.MehtaandRohitMehta(S.ChandPublishing)
3. DigitalLogicandComputerdesignM.MorrisMano(Pearson)5.ConceptsofElectronicsD. C.Tayal(HimalayaPublishinghouse)
4. DigitalSystemandApplication,GuptaKumar,PragatiPrakashan

CORE–I:PAPER-XI
LAB:Credit-1

(Minimum6experimentsaretobedone)

1. Tomeasure(a)Voltage,and(b)TimeperiodofaperiodicwaveformusingCROandtotestaDiodeandTransistorusingaMillimeter.
2. Todesignaswitch(NOTgate)usingatransistor.

3. ToverifyanddesignAND,OR,NOTandXORgatesusingNANDgates.
4. HalfAdder,FullAdderand4-bitbinaryAdder.
5. HalfSubtractor,FullSubtractor,Adder-SubtractorusingFullAdderI.C.
6. TobuildFlip-Flop(RS,Clocked-RS,D-typeandJK)circuitsusingNANDgates.
7. Todesignanastablemultivibratorofgivenspecificationsusing555Timer.
8. Todesignamonostablemultivibratorofgivenspecificationsusing555Timer.

ReferenceBooks:

1. BasicElectronics:ATextBookslabmanual ,P.B.Zbar,A.P.Malvino,M.A.Miller,1994,Mc-GrawHill.
2. OP-AmpsandLinearIntegratedCircuit,R.A.Gayakwad,4thedition,2000,PrenticeHall.
3. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.ElectronicDevicesandcircuitTheory,R.L.BoylestadandL.D.Nashelsky,2009,Pearson.

CORE–I:PAPER-XII

QUANTUMMECHANICSANDAPPLICATIONS:Credit-3

CO-1: To understand Properties and physical interpretation of wave function and its application, knowledge inprobability current density, significance of momentum space transformation and time dependent Schrödingerequation.

CO-2:ToexplainTimeindependentSchrödingerequation,Eigenvalue,Eigenfunction,generalizedsolutionofstationarystates,knowledgeinwavefunctionanddiscreteenergylevel.

CO-3: Basic knowledge in quantum mechanical operators, Eigen value and Eigen function, UncertaintyrelationandGaussianwavepacket.

CO-4:AcquiretheknowledgeinapplicationofSchrödingerequationindifferentpotentialbarriers,conceptofsimpleharmonicoscillator.

CO-5:Apply theacquired knowledgetosolvevariousnumericalproblems.

UNIT-I

Schrodingerequation: TimedependentSchrodingerequation,Propertiesof WaveFunction,Physicalinterpretationofwavefunction,Wavefunctionofafreeparticle,Normalization,Probabilitycurrentand probabilitycurrentdensitiesinthreedimensions,LinearityandSuperpositionPrinciple,WavePacket ,FourierTransformTheorem ,Momentum spacewavefunctionanditssignificance,Representationofpositionvectorinmomentumspace.Schrodingerequationin momentumspace.

UNIT-II

Time Independent Schrodinger equation in1-D, 2-D and 3-D, Hamiltonian,stationary states and energyEigenvalues,expansionofanarbitrarywavefunctionasalinearcombinationofenergyEigenfunctions, General solution of the time dependent Schrodinger equation in terms of linear combinations of stationarystates. General Discussion of Bound states in an arbitrary potential: Continuity of wave function, Boundaryconditionandemergenceofdiscreteenergylevels.

UNIT-III

Operators

:Operators,CommutatorAlgebra,Position,Momentum,AngularMomentumandEnergyoperators,HermitianOperators,ExpectationValue,Expectationvaluesofpositionandmomentum, EhrenfestTheorem,EigenvaluesandEigenfunctionsofHermitianOperator,EnergyEigenSpectrum,Degeneracy,OrthonormalityofEigenfunctions,LinearDependance,Orthogonalisation,UncertaintyRelation-Uncertaintyproduct,minimumuncertaintywavepacket-GaussianWavePacket.

UNIT-IV

Application toone dimensional problem-One dimensional infinitely rigid Box- Energy Eigen valuesandEigen functions, normalization,quantumdotas anexample,Quantum mechanicalscatteringandtunnelingin one dimension across a PotentialStep and Rectangular Potential Barrier, FiniteSquare well potential,Quantummechanicsof simpleHarmonicOscillator-EnergyLevelsandEnergyEigenfunctions,groundstate,zeropointenergy.

TextBooks:

1. IntroductiontoQuantumTheoryDavidPark(DoverPublications)
2. IntroductiontoQuantumTheory,D.J.Griffiths(Pearson)
3. QuantumMechanics:Conceptsandapplications,N.Zettili,Wiley

ReferenceBooks:

1. QuantumMechanics,TheoryandapplicationsA.GhatakandS.Lokanathan (McMillanIndia)
2. QuantumMechanics-G.Aruldhas(PrinticeHallofIndia)
3. QuantumPhysics–S.Gasiorowicz(Wiley)
4. QuantumMechanics-G.R.ChatwalandS.K.Anand
5. QuantumMechanics-J.L.PowellandB.Craseman(Narosa)
6. Introduction to Quantum Mechanics M.Das and P.K.Jena (ShriKrishnaPublication).

CORE–I:PAPER-XII
LAB:Credit-1

UseC/C++/
ScilabforsolvingthefollowingproblemsbasedonQuantummechanicslike(Usefinit
edifferencemethod,matrixmethod, ODESolvermethodinallcases)

1. Solvethes-waveSchrodingerequationforthegroundstateandthefirstexcitedstateoftheHydrogenatom:

$$\frac{d^2y}{dr^2} = A(r)\,u(r), A(r) = \frac{2m}{\hbar^2}\,[V(r) - E], V(r) = -\frac{e^2}{r}$$

Where,‘m’isthereducedmassof theelectron.Obtaintheenergyeigenvaluesandplot thecorrespondingwavefunctions.Rememberthatthegroundstateenergyofthehydrogenatomis ~-13.6ev.Takee=3.795$\sqrt{(eV\text{Å})}$,ħc=1973 (eVÅ) andm=0.511×10^6eV/c^2.

2. SolvetheS-WaveradialSchrodingerequationforanatom:

$$\frac{d^2y}{dr^2} = A(r)\,u(r), A(r) = \frac{2m}{\hbar^2}\,[V(r) - E],$$

Where,‘m’isthereducedmassofthesyste

m(Whichcanbechosentobethemassofanelectron),forthescreenedcoulombpotential:$V(r) = -\frac{e^2}{r}e^{-r/a}$

Findtheenergy(ineV)ofthegroundstateoftheatomtoanaccuracyofthesignificantdigits.

Also; plotthecorrespondingwavefunction.Takee=3.795 (evÅ),ħc=1973(eVÅ)andm=0.511 ×10^6 eV/c2, andα=3Å,5Å,7Å.Thegroundstateenergyisexpectedtobeabove-12eVinallthreecases.

3. SolvetheS-WaveradialSchrodingerequationfor aparticleofmassm:

$$\frac{d^2y}{dr^2} = A(r)\,u(r), A(r) = \frac{2m}{\hbar^2}\,[V(r) - E]$$

FortheanharmonicOscillatorpotential:$V(r) = \frac{kr^2}{2} + \frac{br^3}{3}$.

Findthegroundstateenergy(inMeV)oftheparticletoanaccuracyofthreesignificant

digits.Also,plotthecorrespondingwavefunction.Choose m=940MeV/C^2 ,k=100MeV/fm^2,b=(0,10,30)MeV/fm^3.Intheseunits, c= 197.3MeVfm.[Theground state energy is expected to lie between90and110MeVforallthreecases].

4. SolvetheS-WaveradialSchrodingerequationforthevibrationsofhydrogenmolecule:

$$\frac{d^2y}{dr^2} = A(r)\,u(r), A(r) = \frac{2m}{\hbar^2}\,[V(r) - E]$$

Where,‘m’isthereducedmasofthetwo-atomsystemfortheMorsepotential

$$V(r)=D(e^{-2\alpha r}-e^{-\alpha r})$$

Wherer=r-r_0.

Findthelowestvibrationalenerg y(inMeV)ofthemoleculetoanaccuracyofthreesignificantdigits.Alsoplotthecorrespondingwave functionsforthechoicesgiven below:

m=940x10^6 ev/c^2, D=0.755501ev, α=1.44,

r

$_0$=0.131349Åm=940x106ev/c^2,D=0.755501ev,α=1.44,r_0

=0.131349Å

Laboratorybasedexperiments:

1. StudyofElectronspinresonance-determinemagneticfieldasafunctionoftheresonancefrequency.
2. StudyofZeemaneffect:withexternalmagneticfield;Hyperfinesplitting
3. ToshowthetunnelingeffectintunneldiodeusingI-Vcharacteristics.
4. QuantumefficiencyofCCDs

ReferenceBooks:

1. Schaum'soutlineofProgrammingwithC++.J.Hubbard,2000,McGraw–HillPublication
2. Numerical Recipes in C:The Art of Scientific Computing,W.H.Press etal.,3rd Edn.,2007,CambridgeUniversityPress.
3. AnintroductiontocomputationalPhysics,T.Pang,2ndEdn.,2006,Cam-bridgeUniv.Press
4. SimulationofODE/PDEModelswithMATLAB,OCTAVEandSCILAB:Scientific andEngineeringApplications:A.VandeWouwer,P.Saucez,C.V.Fernndez.2014Springer.
5. Scilab(AFreeSoftwaretoMatlab): H. Ramchandran,A.S. Nair. 2011S.ChandandCo.
6. Scilab Image Processing: L.M.Surhone.2010 Betascript PublishingISBN:9786133459274

SEMESTER–VI

CORE–I:PAPER-XIII

SOLIDSTATEPHYSICS:Credit-3

CO-1:Tounderstand theConceptofcrystalstructureandproperties,X-rayDiffraction,Bragg'sandLaue'scondition.

CO-2:Conceptual understandingof Lattice vibration,Einsteinand Debyespecific heat theoriesof solids,knowledgeinBandtheory,Kroning-PennymodelandHallEffect.

CO-3:UnderstandingtheConceptinmagneticanddielectricpropertiesofmaterials.

CO-4 : Basic knowledge on LASER and its generation, types. Conceptual understanding ofsuperconductivityanditstype,London'sEquation,PenetrationDepthandBCStheory.

CO-5:ToApplytheacquiredknowledgeinexperiments.

UNIT-I

CrystalStructure: Solids,AmorphousandCrystallineMaterials,Lattice translation Vectors,Lattice withaBasis.CentralandNon-CentralElements.UnitCell,MillerIndices,Typesof Lattices,ReciprocalLattice, Brillouin zones, Diffraction of X- rays by crystals, Bragg's Law, Laue's Condition, Atomic and GeometricalFactor.

UNIT-II

ElementaryLatticeDynamics: LatticeVibrationsandPhonons:Linear,MonoatomicandDiatomic

Chains, Acousticaland Optical Phonons, Qualitative Description of the phononspectrum insolids, DulongandPetitsLaw,EinsteinandDebyetheoriesofspecificheatofsolids,r^3Law.

Elementary band theory: Kroning-Penny model of band Gap, Conductor,Semiconducto r(PandNtype)andinsulator,ConductivityofSemiconductor,mobility,HallEffect,Measurementofconductivity(four probemethod)andHallCo-efficient.

UNIT-III

MagneticPropertiesofMatter: Dia-,Para-,Ferri-andFerro-magneticMaterials, ClassicalLangevins theoryofdiaandParamagnetic Domains,Curieslaw,WeissTheoryofFerromagnetismandFerromagneticDomains,DiscussionofB-HCurve,HysteresisandEnergyLoss.

DielectricPropertiesofMaterials: PolarizationLocalElectricalField atan Atom,DepolarizationField,ElectricSusceptibility,Polarizability,ClausiusMosottiEquation,Classicaltheoryof ElectronicPolarizability.

UNIT-IV

Lasers: EinsteinsAandBco-efficientnts,MetastableStates,SpontaneousandStimulatedemissions,Optical Pumpingand populationInversion,ThreeLeveland FourLevelLasers, Ruby Laserand He-NeLaser.

Superconductivity: ExperimentalResults,CriticalTemperature, Critical magnetic field, Meissnereffect, Type-Iand Type-IISuperconductors,London's EquationandPenetrationDepth,Isotopeeffect,IdeaofBCStheory(Noderivation).

TextBooks:

1. IntroductiontoSolidStatePhysics-CharlesKittel(WileyIndia)
2. LASERS:Fundamentalsand Applications- Thyagarajan and Ghatak(McMillanIndia)

ReferenceBooks:

1. SolidStatePhysics-N.W.AshcroftandN.D.Mermin(Cengage)
2. SolidStatePhysics-R.K.PuriandV.K.Babbar(S.ChandPublication)
3. SolidStatePhysicsS.O.Pillai(NewAgePublication)

4. LasersandNon-linearOpticsB.B.Laud(WileyEastern)

5. ElementsofSolidStatePhysics-J.P.Srivastava(PrenticeHallofIndia)
6. ElementarySolidStatePhysics-AliOmar(AddisonWiley)
7. SolidStatePhysics,GuptaandKumar,PragatiPrakashan.

CORE–I:PAPER-XIII

LAB:Credit-1

(Minimum4experimentsaretobedone)

1. Measurementofsusceptibilityofparamagneticsolution(Quinck'sTube-Method)
2. TomeasuretheMagneticsusceptibilityofSolids.
3. TomeasuretheDielectricConstantof adielectricMaterialswithfrequency
4. TodeterminetheHallcoefficientofasemiconductorsample.
5. To draw theBHcurveof Fe usingsolenoidand todeterminetheenergylossfromHysteresis
6. Tomeasurethebandgapofagivensemiconductorbyfour-probemethod.

ReferenceBooks:

1. AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop,1971,AsiaPublishingHouse.
2. AdvancedlevelPhysic sPracticals,MichaelNelsonandJonM.Ogborn,4thEdition,reprinted1985,HeinemannEducationalP ublishers.
3. ATextBooksBookofPracticalPhysics,I.PrakashandRamakrishna,11Ed.,2011 ,KitabMahal
4. ElementsofSolidStatePhysics,J.P.Srivastava,2ndEd.,2006,Prentice-HallofIndia.

CORE–I:PAPER-XIV

ELECTROMAGNETICTHEORY:Credit-3

CO-1:PhysicalsignificanceofMaxwellEquationandits application tofree space,LorentzandCoulombgaugetransformation,poyntingtheorem,conceptofenergydensity.

CO-2:AnalysisofMaxwell'sequationsindifferentmediaandPhysicalsignificanceofrelaxationtime,skindepth,Electricalconductivityofionizedgases,plasmafrequency.

CO-3:BasicunderstandingofpolarizationofEMwave,anddifferenttypesofcrystals,PhaseRetardationPlatesand RotatoryPolarization.

CO-4:ConceptualunderstandingofEMWapplicationinboundedmedia,planeinterface,dielectricmedia,Brewster'slaw,TIR,Evanescentwave,metallicreflection.

CO-5:ToApply the acquired knowledge for visualize basic concept ofphenomenon of lightinvariousexperiments

UNIT-I

Maxwell Equations: Maxwellsequations, Displacement Current, Vector andScalarPotentials,Gauge Transformations:Lorentz andCoulombGauge,Wave Equations,PlaneWaves in free space andcharacteristics,PoyntingTheoremandPoyntingVector,Electromagnetic (EM) Energy Density,PhysicalConceptofElectromagneticFieldEnergyDensity.

UNIT-II

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuumandisotropicdielectricmedium,transversenatureofplaneEMwaves,

refractiveindexanddielectricconstant, wave impedance, Propagation through conducting media, relaxation time,skindepth,Electricalconductivityofionizedgases,plasmafrequency,refractiveindex,skindepth,applicationt opropagationthroughionosphere.

UNIT-III

Polarization of Electromagnetic Waves: Description of Linear, Circular and EllipticalPolarization,uniaxialandbiaxialcrystals,lightpropagationinuniaxialcrystal,doublerefr action,polarizationbydoublerefraction,NicolPrism,Ordinaryand extraordinary refractive indices,ProductionanddetectionofPlane,CircularlyandEllipticallypolarizedlight,

Phase Retardation Plates: Quarter-Wave and Half- Wave Plates. BabinetsCompensatoranditsUses,AnalysisofPolarizedLight.

RotatoryPolarization : OpticalRotation,BiotsLawsforRotatoryPolarization,FresnelsTheoryofopticalrotation,Calculationofangleofrotati on, Experimental verification of Fresnels theory,Specificrotation,Laurentshalf-shadepolarimeter.

UNITIV

EMWaveinBoundedMedia: Boundaryconditionsat a plane interface between two media,ReflectionandRefractionofplanewavesatplaneinterfacebetweentwodielectricmedia,LawsofReflectionand Refraction,Fresnel'sFormulaeforperpendicularandparallelpolarizationcases,Brewster'slaw,ReflectionandTrans missioncoefficients,Totalinternalreflection,evanescentwaves,Metallicreflection(normalIncidence)

TextBooks:

1. IntroductiontoElectrodynamics,D.J.Griffiths(Pearson)2. PrinciplesofOptics-MaxBornandE.Wolf.

ReferenceBooks:

1. ClassicalElectrodynamicsbyJ.D.Jackson.
2. Foundationofelectromagnetictheory:RitzandMilford(Pearson).

3. ElectricityandMagnetism:DCTayal(HimalayaPublication)

4. Optics:A.K.Ghatak

5. ElectricityandMagnetism:Chattopadhyaya,Rakhit(NewCentral)

6. ElectromagneticTheory,GuptaandKumar,PragatiPrakashan

CORE–I:PAPER-XIV

LAB:Credit-1

(Minimum4experimentsaretobedone):

1. ToverifythelawofMalusforplanepolarizedlight.
2. TodeterminethespecificrotationofsugarsolutionusingPolarimeter.
3. ToanalyzeellipticallypolarizedLightbyusingaBabinetscompensator.
4. Todeterminetherefractive indexofliquid bytotalinternalreflectionusingWollastonsair-film.
5. TodeterminetherefractiveIndexof(1)glassand(2)aliquidbytotalinternalreflectionusingaGaussianeyepiece.
6. Tostudythepolarizationoflightbyreflectionanddeterminethepolarizingangleforair-glassinterface.
7. ToverifytheStefan'slawofradiationandtodetermineStefan'sconstant.
8. TodeterminetheBoltzmannconstantusingV-IcharacteristicsofPNjunctiondiode.

ReferenceBooks:

1. AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop,1971,AsiaPublishingHouse.

2. AdvancedlevelPhysicsPracticals, MichaelNelson andJonM. Ogborn, 4Th Edition,reprinted 1985,HeinemannEducationalPublishers

3. ATextBooksBookofPracticalPhysics,I.PrakashandRamakrishna,11 Ed.,2011,KitabMahalElectromagneticFieldTheoryfor Engineersand Physicists,G.Lehner,2010,Springer

CORE –I:PAPER-

XVSTATISTICALMECHANICS:Credit-

3

CO-1: Understandingtheconceptofensemblesanditspartitionfunction,phase

spaceandthermodynamicrelations,MBdistributionlaw.

CO-
2
:Conceptualunderstandingofadditionofentropy,SackurTetrodeequation,LawofequipartitionofEnergyanditsa pplication.

CO-3: Basic postulates and different distribution ofFermi andDiracparticlesandB-Econdensation.

CO-4:BasicknowledgeinthermalandBlackbodyradiation, Conceptofdifferent laws ofradiationandtheirexperimentalverification.

CO-5: Applytheacquiredknowledgeforanalyzethe laws radiationanddifferentdistributionfunctionsusingcomputationalanalysis.

UNIT-I

ClassicalStatistics-I: MacrostateandMicrostate,ElementaryConceptof Ensemble,Microcanonical,CanonicalandGrandCanonicalensemble,PhaseSpace,EntropyandThermodynamicPro bability,Maxwell-BoltzmannDistributionLaw,PartitionFunction.

UNIT-II

Classical Statistics-II : Thermodynamic Functions ofanIdealGas,classical Entropy Expression, GibbsParadox,SackurTetrode equation, Lawof equipartitionof Energy(with proof)-ApplicationstoSpecificHeatanditsLimitations,ThermodynamicFunctionsofatwoenergylevelssystem,NegativeTe mperature.

UNIT-III

QuantumStatistics: Identicalparticles,macro statesandmicrostates,FermionsandBosons, Bose Einsteindistributionfunctionand Fermi-Diracdistribution function. Bose-Einstein Condensation,BosedeviationfromPlanck’slaw,EffectoftemperatureonFermi-Diracdistribution function,degenerateFermigas,DensityofStatesFermienergy.

UNIT-IV

Radiation

:PropertiesofThermalRadiation,BlackbodyRadiation,PureTemperaturedependence,Kirchhoff'slaw,Stefan Boltzmann law:Thermodynamic proof, Radiation Pressure, Wein's Displacementlaw,Wien'sdistributionLaw,Saha'sIonizationFormula,RayleighJeansLaw,UltraVioletcatastrophe.

Planck'sLawofBlackbodyRadiation: Experimentalverification,Deductionof

(1) Wien'sDistributionLaw,(2)RayleighJean'sLaw,(3)StefanBoltzmannLaw,
(4)Wein'sDisplacementLawfromPlanck'sLaw.

TextBooks:

1. IntroductiontoStatisticalPhysicsbyKersonHuang(Wiley).
2. StatisticalPhysics,BerkeleyPhysicsCourse,F.Reif(TataMcGraw-Hill)

ReferenceBooks:

1. StatisticalMechanics,B.K.AgarwalandMelvinEisner(NewAgeInter-national)
2. Thermodynamics,KineticTheoryandStatisticalThermodynamics:FrancisW.SearsandGerhardL.Salinger(Narosa)
3. StatisticalMechanics:R.K.PathriaandPaulD.Beale(AcademicPress)
4. StatisticalMechanics:SharmaandSatyal,KalyaniPublishing
5. BasicStatisticalMechanics,GuptaandKumar,PragatiPrakashan

CORE–I:PAPER-XV
LAB:Credit-1

UseC/C++/Scilabforsolvingtheproblems basedonStatisticalMechanicslike

1. PlotPlanck'slawforBlackBodyradiationandcompareitwithWein's.
2. LawandRaleigh-JeansLawathightemperature(roomtemperature)andlowtemperature.
3. PlotSpecificHeatofSolidsbycomparing(a)Dulong-Petitlaw,
   (b)Einsteindistributionfunction,
   (c)Debyedistributionfunctionforhightemperature(roomtemperature)andlowtemperatureandcomparethemforthese twocases
4. PlotMaxwell-Boltzmanndistributionfunctionversustemperature.
5. PlotFermi-Diracdistributionfunctionversustemperature.
6. PlotBose-Einsteindistributionfunctionversustemperature.

ReferenceBooks:

1. ElementaryNumericalAnalysis,K.E.Atkinson,3rdEdn.2007,WileyIndiaEdition
2. StatisticalMechanics,R.K. Pathria,Butterworth Heinemann:2nd Ed.,1996,OxfordUniversityPress.
3. Thermodynamic, Kinetic Theory and Statistical Thermodynamics, FrancisW.SearsandGerhardL.Salinger,1986,Narosa.

1. ModernThermodynamicswithStatisticalMechanics,CarlS.Helrich,2009,Springer
2. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB:ScientificandEngineeringApplications:A.VandeWouwer,P.Saucez,C.V. Fernndez. 2014SpringerISBN:978-3319067896
3. Scilabbyexample:M.Affouf,2012.ISBN:978-1479203444
4. ScilabImageProcessing:L.M.Surhone.2010,BetascriptPub.,ISBN:978613345927

MULTIDISCIPLINARYCOURSE

1. **NanoMaterialsandApplications(3credits)Theory:2credits**

CO-1:Basicunderstandingofnanostructuredshape,applicationof

Schrodingerequationinnanostructured

CO-2:Understandingofnanomaterialsynthesis

CO-3:Understanding of nanomaterials differentCharacterizationCO-

4:UnderstatingofdifferentopticalpropertiesofnanomaterialsCO-

5:ApplytheaboveconceptsinExperiments

UNIT1:NANOSCALESYSTEMS:

Lengthscales in physics,Nanostructures:1D,2Dand3Dnanostructures(nano dots, thinfilms,nanowires, nanorods),Bandstructureanddensityof statesof materialsat nanoscale,SizeEffectsinnanosystems,Quantumconfinement:Applicationsof Schrodingerequation-Infinitepotentialwell,potentialstep,potentialbox,quantumconfinementofcarriersin3D,2D, 1Dnanostructures anditsconsequences.(10Lectures)

UNIT2:

SYNTHESISOFNANOSTRUCTUREMATERIALS:TopdownandBottom upapproach,Photolithography. Ball milling. Gas phase condensation. Vacuumdeposition. Physical vapordeposition (PVD): Thermal evaporation, E-beamevaporation,PulsedLaserdeposition. Chemicalvapordeposition(CVD).Sol-Gel.Electrodeposition.Spraypyrolysis.Hydrothermalsynthesis.Preparation through colloidal methods.MBE growth of quantumdots. (8Lectures)UNIT3:

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy.

ScanningElectronMicroscopy.TransmissionElectronMicroscopy.AtomicForceMicroscopy.ScanningTunnelingMicroscopy.(8Lectures)

UNIT4:

OPTICALPROPERTIES:Coulombinteractioninnanostructures. Concept ofdielectricconstantfornanostructuresandchargingofnanostructure.Quasi-particles andexcitons.Excitonsindirectandindirectbandgapsemiconductornanocrystals. Quantitativetreatmentofquasi-particlesandexcitons,chargingeffects.Radiativeprocesses:Generalformalization-absorption,emissionandluminescence.Opticalpropertiesof heterostrcturesandnanostructures.(14Lectures)

Referencebooks:

1. C.P.Poole,Jr.FrankJ.Owens,IntroductiontoNanotechnology(WileyIndiaPvt.Ltd.).

2. S.K. Kulkarni,Nanotechnology: Principles&Practices(CapitalPublishingCompany)

3. K.K .ChattopadhyayandA.N.Banerjee,IntroductiontoNanoscienceandTechnology(PHILearningPrivateLimited).

4. RichardBooker,EarlBoysen,Nanotechnology(JohnWileyandSons).

5. M.Hosokawa,K.Nogi,M.Naita,T.Yokoyama,NanoparticleTechnologyHandbook(Elsevier,2007).

6.BharatBhushan,SpringerHandbookofNanotechnology(Springer-Verlag,Berlin,2004).

LABORATORY:1credit

1. Synthesisofmetalnanoparticlesbychemicalroute.
2. Synthesisofsemiconductornanoparticles.
3. SurfacePlasmonstudyofmetalnanoparticlesbyUV-Visiblespectrophotometer.
4. XRDpatternofnanomaterialsandestimationofparticlesize

.5.Tostudytheeffectofsizeoncolorofnanomaterials.

6. Growthofquantumdotsbythermalevaporation.
7. Fabricateathinfilmofnanoparticlesbyspincoating(orchemicalroute)andstudytransmittancespectrainUV-Visibleregion.

ReferenceBooks:

1. C.P.Poole,Jr.FrankJ.Owens,IntroductiontoNanotechnology(WileyIndiaPvt.Ltd.).
2. S.K.Kulkarni,Nanotechnology:Principles&Practices(CapitalPublishingCompany).
3. K.K .ChattopadhyayandA.N.Banerjee,IntroductiontoNanoscience&Technology(PHILearningPrivateLimited).
4. RichardBooker,EarlBoysen,Nanotechnology(JohnWileyandSons).

2. BIOPHYSICS,Theory:3credits

CO-1:BasicfundamentalsoflivingorganismanditsinteractionsindomainsofPhysicsinbiologyCO-2:Understatingofheattransferinbiomaterialsanditsmechanism
CO-3:Diversifyingofthermal,statisticalphysicsinbiologicaldomain.
CO-4:UnderstatingfluidmechanismsinlivingorganisminthedomainofPhysics

UNIT1:

Building Blocks&Structureof LivingState: Atoms and ions, moleculesessentialfor life, whatislife.Livingstateinteractions:Forcesandmolecularbonds,electric&thermalinteractions,electricdipoles,casimirinteractions,domainsofphysicsinbiology.(18 Lectures)UNIT2:

HeatTransferinbiomaterials:HeatTransferMechanism,TheHeatequation,Joule heatingof tissue.LivingStateThermodynamics:Thermodynamicequilibrium,firstlawofthermodynamicsandconservationofenergy.Entropy and second law of thermodynamics,Physicsofmanyparticlesystems,Two statesystems, continuous energydistribution, Compositesystems, Casimircontributionoffreeenergy,Proteinfoldingandunfolding.(19Lectures)

UNIT3:

Opensystemsandchemical thermodynamics: Enthalpy, Gibbs FreeEnergyandchemical potential,activationenergyandrateconstants,enzymaticreactions, ATPhydrolysis&synthesis,Entropyofmixing, Thegrandcanonicalensemble,Hemoglobin. Diffusionand transportMaxwell-Boltzmannstatistics,Fick'slawofdiffusion,sedimentationofCell Cultures,diffusioninacentrifuge, diffusionin an electric field, Lateraldiffusionin membranes,Navierstokes equation, low Reynold'sNumberTransport,Activeandpassivemembranetransport.(19Lectures)

UNIT4

Fluids: Laminarand turbulent fluid flow,Bernoulli'sequation,equationof continuity,ventureeffect,Fluiddynamicsofcirculatorysystems,capillaryaction.Bioenergetics andMolecularmotors:Kinesins,Dyneins,and microtubuledynamics,Brownianmotion, ATPsynthesisinMitochondria, Photosynthesis in Chloroplasts, Light absorption in biomolecules, vibrationalspectraofbio-biomolecules.(19Lectures)

ReferenceBooks:

1. IntroductoryBiophysics,J.Claycomb,JQPTran,Jones&BartelettPublishers
2. AspectsofBiophysics,HugheSW,JohnWillyandSons.
3. EssentialsofBiophysicsbyPNarayanan,NewAgeInternational

3. IntroductiontoSpectroscopy:Theory:3credits

CO-1:Basicunderstanding of atomic models anditsspectroscopy natureCO-
2:ConceptualunderstandingofSpectraofAlkalielements
CO-3:UnderstatingthebasicofX-rayanditsapplicationsCO-
4:Understatingmolecularspectroscopy

UNIT1:

VectorAtomicModel:Inadequaciesof BohrandBohr-Sommerfeldatomicmodelsw.r.t.spectrumofHydrogenatom(finestructureof H-alphaline).Modificationis due to thefinite massof the nucleusandtheDeuteronspectrum.Vectoratomicmodel(Stern-Gerlachexperimentincluded)andphysical&geometricalinterpretationsof variousquantum numbersforsingle& many valenceelectronsystems.LS& JJ couplings,spectroscopic notation forenergystates,selection rulesfor transition of electronsand intensity rules for spectral lines.Fine structure of H-alpha line based on vector atomic model.(10lectures)

UNIT2:

SpectraofAlkali& AlkalineElements:Spectraofalkalielements:Screeningconstantsfors,p,d& amp; f orbitals;sharp, principle, diffuse & amp; fundamental Series; doublet structure of spectra and finestructureofSodiumDline.Spectraofalkalineelements:Singletandtripletstructureofspectra.(6lectures)

UNIT3:

X- rays&X-RaySpectra:Nature&production,Continuous X-rayspectrum&Duane-Hunt' s law,Characteristic X-ray spectrum & Mosley's law, Fine structure of CharacteristicX-rayspectrum,andX-rayabsorptionspectrum.(7lectures)

UNIT4:

MolecularSpectra:Discretesetof amolecule'selectronic,vibrationalandrotationalenergies.Quantization of vibrational energies, transition rules and pure vibrationalspectra. Quantization of rotationalenergies, transition rules, pure rotational spectra and determination of inter nuclear distance. Basics of UVVisible&photoluminescencespectroscopy(7lectures)

ReferenceBooks:

1. H.E.White,"IntroductiontoAtomicSpectra",McGrawHill,19348.
2. C.N.Banwell,E.M.McCash,"FundamentalsofMolecularSpectroscopy",McGrawHill,2017,4e9.
3. RMurugeshan,KiruthigaSivaprasath,"ModernPhysics",S.ChandPublishing,2019,18e10.
4. S.L.Gupta,V.Kumar,R.C.Sharma,"ElementsofSpectroscopy",PragatiPrakashan,Meerut,2015,27

SKILLENHANCEMENTCOURSE

SEC-1

RENEWABLEENERGYANDENERGYHARVESTING:Credit-2

Theory:30Lectures

CO-1:Basicunderstandingofalternativesourcesofenergy.
CO-2:Conceptualunderstandingandimportanceofsolarcell,characterization
CO-3: Understating the energy harvesting and its applications using wind and piezoelectric materialCO-4: Understatingthe electromagnetic energyharvestinganditsapplications

UNIT-1

FossilfuelsandAlternateSourcesofenergy:

Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energysources.Anoverviewof developmentsinOffshoreWindEnergy,TidalEnergy,Waveenergysystems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogasgeneration,geothermalenergytidalenergy,Hydroelectricity.

UNIT-2

Solarenergy:

Solarenergy,itsimportance,storageofsolarenergy,solarpond,non-convectivesolarpond,applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation,solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics ofphotovoltaic(PV)systems,PVmodelsand equivalent circuits,andsuntrackingsystems.

UNIT-3

WindEnergy harvesting:

Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines,Powerelectronic interfaces,andgridinterconnectiontopologies.

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect,materials and mathematical description of piezoelectricity, Piezoelectric parameters and modelingpiezoelectric generators,Piezoelectric energyharvestingapplications,Humanpower.

UNIT-4

ElectromagneticEnergyHarvesting:

Linear generators, physics mathematical models, recent applications 42 Carbon captured technologies,cell,batteries,powerconsumptionEnvironmentalissuesandRenewablesourcesofenergy,sustainability.

ReferenceBooks:

1. Non-conventionalenergysources-G.DRai-KhannaPublishers,NewDelhi
2. Solarenergy-MPAgarwal-SChandandCo.Ltd.
3. Solarenergy-SuhasPSukhativeTataMcGraw-HillPublishingCompanyLtd.
4. GodfreyBoyle,“RenewableEnergy,Powerforasustainablefuture”,2004,OxfordUniversityPress,inassociationwithTheOpenUniversity.
5. Dr.PJayakumar,SolarEnergy:ResourceAssesmentHandbook,2009
6. J.Balfour,M.ShawandS.Jarosek,Photovoltaics,LawrenceJGoodrich(USA).
7. http://en.wikipedia.org/wiki/Renewable_energy

SEC-2

AppliedOpticsandPhotonics:Credit-3

CO-1: Basic understanding of different sources and detectors, principles.CO-2:Conceptualunderstandingoffrequencyfilteringanditsapplication.

CO-3: Basic concept of holography,and its application in microscopy and interferometry.CO-4:BasicknowledgeinOpticalfiber,anditsprincipleandapplicationinsensors.

CO-5:ApplytheacquiredknowledgeinExperiments

Theory:Credit2Unit-1

SourcesandDetectors

Lasers,Spontaneousandstimulatedemissions,Theoryoflaseraction,Einstein'scoefficients,lightamplification,Characterizationoflaserbeam,He-Nelaser,SemiconductorLasers.

FourierOpticsandElectronMicroscopyU nit-2

ConceptofspatialFrequencyFiltering,Fourier Transformingpropertyofathinlens.

ElectronMicroscope,WorkingPrinciple,Typesofelectronmicroscope:TEM,SEM(BASICS),Applicationsofelect ronmicroscope,Advantagesandlimitations ofelectronmicroscope

Unit-3

Holography

Basicprincipleandtheory:coherence,resolution,Typesofholograms,whitelightreflectio nhologram,applicationofholographyinmicroscopy,interferometry.

Unit-4

Photonics:FiberOptics

Optical fibersand their properties, Principal of light propagation through a fiber, The numericalaperture, Attenuation in optical fiber and attenuation limit, Single mode and multimode fibers, Fiberopticsensors.

LAB:Credit-1

1. ExperimentonLasers:

TofindthewidthofthewireorwidthoftheslitusingdiffractionpatternobtainedbyaHe-Neorsolidstatelaser.

2. ExperimentsonSemiconductorSourcesandDetectors

a. V-IcharacteristicsofLED

b. PhotovoltaicCell

3. ExperimentsonHolographyandinterferometry.

a. ConstructingaMichelsoninterferometeroraFabryPerotinterferometer.

b. ConstructingaMach-Zenderinterferometer.

4. ExperimentsonPhotonics:FiberOptics

a. Tomeasurethenumericalapertureofanopticalfiber.

b. Tostudythevariationofthebendinglossinamultimodefiber.

c. Todeterminethepowerlossatasplicebetweentwomultimodefiber

ReferenceBooks:

a. FundamentalofOptics,F.A.Jenkins&H.E.White,1981,TataMcGrawhill.

b. LaserFundamentalsandApplications,K.Thyagarajan andA.K.Ghatak,2010-TataMcGrawhill.

c. FiberOpticsthrough experiment,A.K.Ghatak,BishnuP.Pal,M.R.Shenoy,Sunil K.Khijwania,2009,viraBook.

d. Fiberopticsandoptoelectronics

,R.P.Khare,OxfordUniversity.e.https://www.wikilectures.eu/w/

Electron_microscopy/principle

IntroductiontoQuantumInformationandComputingCe rdit-03 (02 (Theory)+01(Lab.))

CO-1:BasicunderstandingofQuantumMechanics,linearalgebraofQuantumMechanicsandQuantum Entanglement.
CO-2:BasicideasaboutQuantumGatesandcircuits,statesandqubits.CO-3:TofamiliarwithQuantumAlgorithmandFourierTransform.
CO-4:UnderstandingShor'salgorithmandGrover'salgorithm.
CO-5:Toapplytherequiredknowledgeinquantumcomputinglabs.

Unit-1

IntroductiontoQuantumMechanics

Historyanddevelopmentofquantummechanics,Keyprinciples:superposition,entanglement,andwave-particle duality.

LinearAlgebraforQuantumComputation

Vectorsand vectorspaces,Innerproduct,outerproduct,andHilbertspacesEigenvaluesandeigenvectors.

QuantumEntanglement

Definition and propertiesofentanglement,Bell statesand EPRpairs,Applicationsofentanglement,QuantumTeleportation.

Unit-2

QuantumGatesandCircuits

Basicquantum gates:Pauli-X,Y,Z,Hadamard,Phase,andCNOT,Quantumcircuitsandtheirrepresentation,Deutsch-Joszaalgorithm.

QuantumStatesandQubits

Theconcept ofqubits,Representing qubits:Diracnotationand Blochsphere,Quantum statemeasurements.

Unit-3

IntroductiontoQuantumAlgorithms

Classicalvs.quantumalgorithms,Complexityclasses:P, NP,andBQP.

QuantumFourierTransform(QFT)

Mathematical foundation of QFT, Implementation of QFT in quantum circuits, Applications ofQFT.

Unit-4

Shor'sAlgorithm

Problemstatement:integerfactorization,StepsofShor'salgorithm,Practicalimplementationandsignif icance.

Grover'sAlgorithm

Problemstatement:unstructuredsearch,StepsofGrover'salgorithm,Implementationandapplic ations.

ReferenceBooks:

1. Textbook: "Quantum Computation and Quantum Information" by Michael A. Nielsen andIsaac L.Chuang.

2. J. Preskill,“LecturesnotesonQuantuminformationandcomputation”.

3. Online platform:Qiskit(IBMQuantumExperience).

QuantumComputing:ComputationLabC erdit:01

SL. No.	Topic	ExpectedOutcome
1.	Installation and exploration ofQiskit,IBMQplatform. Introduction to other significantquantumcomputationt oolkits(Pennylane,Quimb,QuTi petc).	1. Implementationofbasicgates(Pauli,Hadamard,RX,RY,RZ,C NOT,CZ,ControlledRotation)usingQiskit. 2. Building basic circuits with singleandEntanglinggates. 3. Understandingquantum, measurement,visualization 4. Building Bellstateand measuringit. 5. Running acircuitthroughaccessibleNISQcomputer.

2.	Complex gate designing, an dsimpleAlgorithmsandprotocols.	1. ToffoligatethroughCNOT,H,S,T,andQiskitin-builtmethods. 2. Multi-controlled,multi-targetgatesthroughToffoliandQiskitMTMCmethod. 3. Designing quantumteleportationprotocolwithBellstate. 4. Designingimperfectquantumteleportationwithn on-maximallyentangledstate 5. Incorporatingnoisemodels(availableinQiskitfordifferentdevices),andsee how noisechangesthe results. 6. Implementation ofDeutsch-JozsaAlgorithm.
3.	QuantumFourierTransform	1. SinglequbitquantumFouriertransform(Hgate). 2. ThreequbitquantumFouriertransform. 3. Multiqubitquantum Fouriertransform(Understandingexponentialgatecomplexity). 4. ApproximatequantumFouriertransformwithpolynomialcomplexity(Establishingerror-complexitytrade off).
4.	QuantumPhaseEstimation	1. Idealcasephas eestimationalgorithmdesigning(wherephasecanbewrittenusingexactlytbits) 2. Approximatecasephaseestimationandunderstandingprobabilityofobtainingcertainaccuracy
5.	Shor's Factorization Algorithm	1. Reduction offactorizationto orderfinding. 2. Implementationoffactorizationalgorithmfor9and15.
6.	QuantumSearchAlgorithm	1. DesigningquantumsearchthroughGrover'salgorithm. 2. Devisingalgorithmforquantumcounting. 3. Understanding O($\sqrt{N}$)complexityforquantumsearch.

ASTRONOMYANDASTROPHYSICS

Credit:3

CO-1:Basicideasaboutcelestialmechanicsandastrometry.CO-2: Tounderstandbasictoolsofastronomy.

CO-3:Basicideasinsolarsystem.

CO-4:Tounderstandthebasicsofstellarparameters.

CO-5:ToApplythebasicknowledgeofAstronomyandAstrophysicsfordoingsomeexperiments.

UNITI: 8Hours

CelestialMechanicsandAstrometry : ThecelestialSphere,Positionsofstars,Propermotionsofstarsandplanets,Distances ofnearbystars.

UNIT2: 8Hours

Tools of Astronomy: Telescopes: Basic Optics, Optical Telescopes, Radio Telescopes, Infrared,Ultraviolet, X-ray, and Gamma-Ray Astronomy – detectors and observatories Gravitational WavesdetectorsandNeutrinodetectorsAll-SkySurveysandVirtualObservatories.

UNIT3: 8Hours

The Solar System: The Sun, The Physical Processes in the solar system, The Terrestrial and theGiantPlanets,FormationofPlanetarySystems.

UNIT4: 8Hours

Basic Stellar Parameters: The brightness of the stars, Colour-magnitude diagrams (The HRdiagrams), The luminosities of the stars, Angular radii of stars, Effective temperatures of stars,Massesandradiiofstars:Binarystars,SearchforExtrasolarPlanets

ReferenceBooks:

1. IntroductiontoStellarAstrophysics,Volume1,Basicstellarobservationsanddata,ByErikaBohm-Vitense,CambridgeUniversityPress
2. AnIntroductiontoModernAstrophysics,SecondEdition,ByCarrollB.W.,OstlieD.A.,PearsonAddisonWesley.
3. "AstrophysicsforPhysicists"byArnabRaiChoudhuri, CambridgeUniversityPress, 2010
4. GalacticAstronomy:StructureandKinematicsbyMihalas&Binney,W.H.Freeman&CoLtd;2ndRevisededition1981.
5. AnIntroductionto Astrophysics: by BaidyanathBasu; Prentice-Hall ofIndia, -NewDelhi-110001

ASTRONOMYANDASTROPHYSICSLAB:
ListofExperiments

1. To becomefamiliarwiththeastronomicalobjectsvisible to nakedeyeinthenightskyusingthesoftware Stellarium.

2. To becomefamiliarwiththeConstellationsinthenight sky usingthesoftwareStellarium.

3. To identifytheretrogrademotion ofMarswithrespectto the Background stars.

4. Toidentifysomeoftheprominent spectral linesinthespectrum ofoursun.

5. To getfamiliarwith thespectra ofdifferentstars.

6. Toextractcoordinatesofastarassumingatelescopeinequatorialmount.Youwillalsolearntheconceptofsiderealtime.

ValueAddedCours

eCOMPUTATIONALMATERIALSMODELLING

Credit-4

CO-1:Basicunderstandingof MolecularDynamic.

CO-2:Conceptualunderstandingof statisticalMechanics

CO-3:Conceptualunderstandingofdifferentinputscriptinmoleculardynamic(LAMMPS)CO-4:Basicunderstandingofdensityfunctionaltheory

CO-5: Apply the acquired knowledge solving problems using software tools . LAMMPS, QuantumExpresso

Theory:3credit

Unit1

Introduction to the course, Some applications of MD simulations, Introduction to Bravais latticesand constructingsimplecrystalswithMATLAB,Introductiontosymmetry–1,SymmetryElements – 1, Symmetryelements-2, Plane groups and their Hermann-Mauguin(HM) symbols,Glidereflection; Examples of writing point groupsymbols; Wyckoff positions, generating 2Dcrystal with MATLAB usingBilbaocrystallographywebsite,Symmetryofspacegroups,Hermannmauguinsymbolsofspacegroups,Translationalsymmetryoperators

Unit2

TheSpace groups,Generationof crystals,Generationof monocliniclattice,IntroductiontoStatistical Mechanics,Introductionto phasespace,Introductionto phaseaverageandtimeaverage,Canonicalensemble;Partitionfunction.

Unit3

Basic introduction to MD, input script for LAMMPS 1, Input script for LAMMPS 2, Input scriptforLAMMPS3,Inputscript,forLAMMPS4.

Unit4

DensityFunctionalTheory:Introduction,Kohnshamequation(KSorbitals,eigenvalues),SolvingKSequation,self-consistency,Vibrationalprinciple,Constraints,Directdiagonalization.

ComputationalMaterialsModellingLab:1credit

LAMMPSexercises1,LAMMPSexercises2,LAMMPSexercises 3,LAMMPSexercises4,LAMMPSexercises5,DFTwithQuantumExpresso:Si2,ConvergenceTest,Si2 band,Si7vacancy

TextBook/References

1. Lee,J.G. (2016).ComputationalMaterialsScience:AnIntroduction,SecondEdition(2nded.).CRCPress.https://doi.org/10.1201/9781315368429

2. https://archive.nptel.ac.in/courses/112/106/112106289/

FourYearHons.withoutResearchS

em-VII

MathematicalMethodsinPhysics

CO1:Understandingof ComplexVariablesandContourIntegration:Gaina comprehensiveunderstandingofcomplexvariablesandcontourintegration techniques, including theirapplicationsinmathematicalanalysis andphysics.

CO2:LearningTensorsforPhysics:Acquireknowledgeandproficiencyin workingwithtensors,afundamentalmathematicaltoolinphysicsusedto describe physical quantities andtheirtransformations.

CO3:UnderstandingGroupTheory:Developa deep understanding of group theory and its roleinphysics,includingapplicationsinsymmetryanalysisandquantummechanics.

CO4:.LearningSpecialFunctionsfor ApplicationsinPhysicalProblems: Master specializedfunctionscommonlyusedinphysicstosolvecomplex problems,enhancingproblem-solvingskillsandexpandingmathematicaltechniques.

Unit-1

Complex Variables: Analytic functions, Contour integrals, Cauchy's integral theorem, Laurent' sseries,singularpoints,residuesandtheResidueTheorem,Evaluationofrealdefiniteandindefiniteintegralsbycontourintegration,indentedsemi-circular contour,evaluation of single andmulti-valuedfunctions,branchpointsand branch cuts, Contour integration involving branchpoint.

Unit-2

Tensors: Introduction, Types of tensor, Invariant tensor, epsilon tensor, Pseudo tensor, the algebraoftensor, Quotient law,MetricTensor, Covariant derivative oftensor, Fundamental Tensor,Cartesian tensor,Christoffelsymbol.

Unit-3

GroupTheory:Definitionsofgroups, subgroupsandclasses, Isomorphism, Homomorphism,Cayley'stheorem,Grouprepresentations,Orthogonalitytheorem, characters,Orthogonalityrelation for group character, Character table, Preliminary idea about infinite group, calculation ofgenerator,CalculationofgeneratorassociatedwithS.U.(2)andSO(3)group,

Unit-4

SpecialFunctions:LegendrePolynomials, generatingfunctions, Recurrence formulae,OrthogonalitypropertiesofLegendre'spolynomialof1stkind,Bessel generatingfunction,Bessel functionof1stand2ndKind, Recurrenceformulae, Orthogonality properties of Bessel'spolynomials,SphericalBesselfunctions,Fourierand Laplacetransformation.

Textbooks:

1. MathematicalMethodsofPhysics byMathews andWalker(W. A.BenjaminInc.)
2. MatricesandTensorsinphysics byA.W.Joshi(NewAgeInternationalPublisher)
3. MathematicalMethodsinthephysicalSciencebyMaryL. Boas(Wiley-India)

ReferenceBooks:

1. MathematicalMethodsforPhysicistbyG.ArfkenandH.Weber,AcademicPress(Elsevier)
2. ElementsofGroupTheorybyA.W.Joshi(New AgeInternationalPublisher)
3. MathematicalPhysicsbyH.K.DasandDr.R.Verma(S.Chand&CompanyL.T.D.)
4. MathematicalPhysicsbyP. K.Chattopadhyaya(NewAgeInternational)

ClassicalMechanics

CO1:Enhancecomprehensionofrigidbodykinematics.CO

2:MastertheHamiltonianformalism.

CO3:Deepenunderstandingofcanonicaltransformationsinvariousphysicalscenarios.

CO4:Graspconceptsrelatedtosmalloscillations.

Unit-1

KINEMATICSOF RIGIDBODY MOTION:

Independentcoordinatesofarigidbody,Orthogonaltransformations,Eulerianangles,infinitesimal rotations, rate of change of vector, Coriolis force, angular momentum and kineticenergy of motion about a point, inertial tensor and the moment of inertia, Eigen values of Inertialtensor and the principal axis transformation, methods of solving rigid body problems and Euler'sequationsof motion,torquefree motion of a rigid body. Heavy symmetrical top with one pointfixed.

Unit-2

HAMILTONIANFORMULATION: CalculusofVariationsandEuler-Lagrange'sEquation, BrachistochroneProblem,Hamilton'sPrinciple,Extensionof Hamilton'sPrincipleto Nonholonomic Systems, Legendre Transformation and the Hamilton Equations of Motion,PhysicalSignificanceof Hamiltonian, Derivation of Hamilton's Equations of Motion from aVariationalPrinciple,Routh'sProcedure,PrincipleofLeastAction

Unit-3

CANONICALTRANSFORMATIONS: CanonicalTransformation,TypesofGeneratingFunction, conditions for canonical transformation, Integral Invariance of Poincare, Poisson Bracket, Poisson's Theorem, Lagrange Bracket, Poisson and Lagrange Brackets as CanonicalInvariant,Infinitesimal Canonical transformation and Conservation Theorems, Liouville's Theorem HamiltonJacobi Theory: Hamilton-Jacobi Equation for Hamilton's Principal Function, Harmonic Oscillator andKepler problem by Hamilton-Jacobi Method, Action-Angle Variables for completely SeparableSystem,KeplerProbleminAction-AngleVariables.

Unit-4

SMALL OSCILLATION: Problem of Small Oscillations, Example of linear triatomic moleculeand twocoupledOscillator,GeneralTheoryof SmallOscillations,NormalCoordinatesandNormalModesofVibration.

TestBooks:

1. ClassicalMechanics-byH.Goldstein(Addison-Wesley)

Referencebooks:

2. ClassicalMechanicsbyS.N.Biswas, BooksandAlliedPublisherLtd.
3. ClassicalMechanicsbyJ.C.Upadhay,HimalayaPublishingHouse.
4. ClassicalMechanicsbyLandauandLiftshitz(ButterWorth)

QUANTUMMECHANICS-1

CO1: Tocomprehend thepostulatesand generalformalism ofquantum

mechanics.CO2:Toacquireknowledgeofquantumdynamics.

CO3: To grasp theconceptsofrotational and orbital angularmomentum.

CO4:Tounderstandspinangularmomentum,additionofspin, andClebsch-GordanCoefficient

Unit–1

GENERALPRINCIPLESOFQUANTUMMECHANICS:
PostulatesofQuantumMechanicsandmeaningofmeasurement,Operatorsandtheirexpectationvalues, . Dirac Notations,Linear vector space, Ket and Bra vectors, Scalar product ofvectors and their properties, Dirac deltafunction,linearoperators, Adjoint operators, UnitaryOperators, Expectation values of dynamical variables and physical interpretation of Hermitianoperators, Eigen values andeigen vectors,orthonormality ofeigenvectors,probabilityinterpretation,Degeneracy,Schmidtmethodof orthogonalization,Expansiontheorem,Completeness and closure properties of the basis set, Coordinate and momentum representations,compatibleanIncompatible observables,Commutatoralgebra,uncertaintyrelationasaconsequenceof non- commutability, minimum uncertainty wave packet, Representations of KetandBra vectorsandoperatorsinmatrixform,Unitarytransformationof basisvectorsandoperators.

Unit–2
QUANTUMDYNAMICS:
Timeevolutionofquantumstates,Timeevolutionoperatoranditsproperties, Schrödinger,Heisenberg and Interaction picture,Equations of motion, Operator method solution of Harmonicoscillator problem,Matrixrepresentation and timeevolution ofcreation and annihilation operator.

Unit–3
ROTATIONANDORBITALANGULARMOMENTUM
Rotation Matrix, Orbital angular momentum operators as generators of rotation, Lx, Ly, Lz and L2and their Commutationrelations,RaisingandLoweringoperators (L+andL-),Lx,Ly,LzandL2 in Spherical Polar coordinates, Eigen values and Eigen functions of Lz and L2(operatormethod),MatrixrepresentationofLx, Ly,Lz andL2.

Unit–4

SPINANGULARMOMENTUM:
Spin½ particles,Paulispin matricesand their properties,Eigen valuesand Eigen functions,Spinand rotations. Total angular momentum: Total angular momentum J, Eigen value problem ofJz and J2 , Angular momentum matrices, Addition of angular momentum and C. G. coefficients forthestateswith(i)j_1=½andj_2=½(ii)j_1=1andj_2=½.

Textbooks:
1. "QuantumMechanics:ConceptsandApplications"byNouredineZettileJohnWileyandsons.

ReferenceBooks:

1. "QuantumMechanics",L.I.SchiffL.I 3rdEd, McGrawHill BookCo.
2. “QuantumMechanics”E.Merzbacher,2ndEd.,JohnWiley&Sons.
3. "Quantum Physics",S.GasiorowiczJohnWiley.
4. " ATextBookofQuantumMechanics"byP.M.Mathews.andVen katesan,TataMcGrawHill.
5. IntroductiontoQuantumMechanics,byD.J.Griffiths,2ndedition,PearsonPubl ications.
6. LecturesonQuantumMechanics,AshokDas, UniversityofRochester,USA(second edition;HindustanBook Agency

LABORATORY:COMPUTATIONALPHYSICS: 4CREDITS

The main goal of this laboratory is to utilize programming languages such as C/C++, Fortran,Matlab, andScilabtotacklestraightforwardproblemsinthefieldsofclassicalmechanics,quantummechanics,and statisticalmechanics.

1. Introductiontotheprogramminglanguage(e.g.C/C++/Fortran/Matlab/ Scilab).Theintroductionisaccompaniedbyexamplesinthefollowinggeneralareas. (a)SortingAlgorithms-- selectionsort,Quicksortetc.(b)Solutionof equation-- Newton's method,Secantmethodetc.(c) Simplenumericalintegratons--Trapezoidalrule, simpson1/3rule.

2. Classical mechanics (2nd order ODE, initial value problems). Euler method, Modified-Euler(predictor-corrector) method, Runge-Kutta method, Leapfrog method, Verlet method, VelocityVerletmethod,each withand without velocitydependentdrag terms, harmonicoscillatorwith damping ,forced one, realistic projectile motion with air drag, realistic planetary orbitcalculation.

3. Quantum Mechanics (2nd order ODE, boundary value and eigenvalue problems). ShootingmethodandNumerov'smethod,examplesofboundstatescalculationfor1Dwells,

quantum harmonicoscillators.Eigenvalueprobleminmatrixform(finitedimensionalbasis),andexact (Lanczos)diagonalization,Variationalcalculationwithorthogonalbasisstates.Time-dependentSchrodingerequation,waveequation.

4. StatisticalMechanics(StochasticandMonteCarloMethods).Uniformrandomnumbergeneration,Randomwalkanddiffusion,MonteCarloIntegration--advantageinhigherdimension, error analysis. Importance sampling and detailed balance. Generation of randomnumbers fromaGaussiandistribution-- Box Miller method, using centrallimittheorem,Samplingpointsfromarbitrary distributions --Metropolissampling andexamples.

ReferenceTextbooks:

1. ComputationalPhysics,N.J.GiordanoandH.Nakanishi,PearsonPrenticeHall(2006)
2. IntroductiontoComputationalPhysics,PaoTang,CambridgeUniversityPress.
3. ComputationalPhysics,S.E.KooninandD.C.Meredith,Addison-WesleyPublishingCompany.
4. ComputationalPhysics,J.M.Thijssen,CambridgeUniversityPress

Sem.-VIII

ClassicalElectrodynamics

CO 1: To understand the covariance formulation of electrodynamics through topicssuchasLorentztransformations, Scalars,Vectors,Tensors, andtheInhomogeneousWave Equation.

CO2:ToexploretheconceptsofLienard-Wiechertpotentialandthefieldofauniformlymoving electron, as well as the propagation of electromagnetic waves in rectangular waveguides.

CO3:Tolearn aboutradiationfromacceleratedcharges.

CO4: To comprehend radiation, scattering, and dispersion phenomena in the context ofelectrodynamics.

UNIT1:

a. Covariantformulationofelectrodynamics:

Lorentztransformation;Scalars,vectorsandTensors;Maxwells equations andequations of continuity in terms of Aμ and Jμ; Electromagnetic field tensor and its dual;Covariant form of Maxwell"s equations; Lagrangian for a charged particle in presence ofexternalelectromagneticfieldandMaxwell'sequationasEuler-Lagrangeequations.

b. **TheInhomogeneousWaveequation:**

Wave equations for potentials, solution by Fourier analysis, Radiation field, Radiation energy,Hertz potential, Computation of radiation fields by Hertz method, electric dipole radiation,multipole-radiation.

Unit–II

a. **Lienard-Wiechart potential and Field of a uniformly moving electron:** Lienard-Wiechartpotential,Fieldsof achargein uniformmotion,Directsolutionof thewave equation,Convectionpotential,Virtualphotonconcept.

b. Waveguides,Propagation ofelectromagneticwavesin rectangularwaveguides.

Unit–III

RadiationfromAcceleratedCharges: Radiationfromanacceleratedcharge,Fields ofanacceleratedchargeradiationatlowvelocity,Caseofvelocityparallelto acceleration,radiationfromcircularorbits,Radiationwithnorestrictionsonthe acceleration or velocity,ClassicalcrosssectionforbremsstrahlunginaCoulombfield,Cherenkovradiation.

Unit–IV

Radiation,scatteringanddispersion:

Radiative damping of a charged harmonic oscillator, forced vibrations, scattering by an individualfree electron, scattering by a bound electron, absorption of radiation by an oscillator, equilibriumbetweenanoscillatorandaradiationfield,effectofa volumedistributionofscatters,scatteringfromavolumedistribution,Rayleighscattering,thedispersion relation.

TextBook:

1. "ClassicalElectricityandMagnetism"byWolfgan gK.H.PanofskyandMelbaPhilips,SecondEdition.

Referencebooks:

1. "ClassicalElectrodynamics",JaksonJD,JohnWiley.

2. 'IntroductiontoElectrodynamics",GriffithsDJ,PrenticeHall.

QUANTUMMECHANICS-II

CO1:Mastertheprinciplesofsolvingmotioninasphericallysymmetricfield.CO2:A

cquireproficiencyinutilizingapproximatemethods.

CO3: Comprehend advanced techniques like the Variational method, W. K. B. method, andTime-dependentperturbationtheory.

CO4:GaininsightintoTime-dependentperturbationtheoryandthescatteringofidenticalparticles.

Unit-1

Motioninasphericallysymmetricfield:

Thehydrogenatom,Reductiontoequivalentonebodyproblem,radialequation, Energyeigenvaluesandeigenfunctions,Degeneracy,Radialprobabilitydistribution, free-particleproblem, Expression of plane waves in terms of spherical waves. Bound states of a 3-D squarewell.

Unit-2

Approximatemethods:

stationary perturbation theory, Rayleigh Schrodinger method for non-degenerate case, firstandsecondorderperturbation,anharmonicoscillator,generaltheoryforthe degenerate case,removalofdegeneracy,linearStarkeffect, normalZeemaneffect.

Unit-3

Variationalmethod: Ground State, First Excited State and Second Excited State of H-atomOne-DimensionalHarmonicOscillator,andHe-atom.

W.K.B.method:Connectionformulas,Bohr-Sommerfeldquantizationrule,Harmonic oscillatorandcoldemission.

Time-dependentperturbationtheory:

Transitionprobability,constantandharmonicperturbation,FermiGoldenrule

Unit-4

Scatteringamplitudeandscatteringcrosssection:

Bornapproximation,applicationtoCoulomban dscreenedCoulombpotentials.Partialwaveanalysis for scattering, optical theorem, scattering from a hard sphere, resonant scatteringfromasquarewell potential.Identicalparticles,Symmetricandantisymmetricwavefunction,Scatteringofidentica lparticles.

TextBook:

1. "QuantumMechanics:ConceptsandApplications"byNouredineZettileJohnWileyandsons.

ReferenceBooks:

1. "QuantumMechanics",L.I.Schiff3rdEd,McGrawHillBookCo.
2. “QuantumMechanics”E.Merzbacher,2ndEd.,JohnWiley&Sons.
3. "QuantumPhysics",S.GasiorowiczJohnWiley.
4. "ATextBookofQuantumMechanics"byP.M.Mathews.andVenkatesan,TataMcGrawHill.
5. IntroductiontoQuantumMechanics,byD.J.Griffiths,2ndedition,PearsonPublications.

Electronics

CO1:EnhanceunderstandingofNetworkAnalysis,BipolarJunctionTransistors,andOperationalAmplifiers
.

CO2:AcquireknowledgeofOscillatorcircuitsandtheirfunctionality.CO3

:MastertheconceptsofDigitalCircuitsandtheirapplications.

CO4:ComprehendtheoperationandusageofOptoelectronicDevicesinelectronicsystems.

Unit-1

NetworkAnalysis:SuperpositionprincipleTheveninandNortonTheorems,BJT,
FET,MOSFET:characteristic,biasing-parameteranalysisFeedbackCircuits.
OperationalAmplifiers:Thedifferentialamplifier,D.C.andA.C.signalanalysis,
integralamplifier,rejectionofcommonmodesignals,CMMR,Theoperational
amplifier,inputandoutputimpedances,ApplicationofoperationalAmplifiersunit gain
buffer,summing,integratingamplifier,Comparator,Operationalamplifierasadifferentiato**r.**

Unit-2

Oscillatorcircuits: Feedbackcriteriaforoscillation,Nyquistcriterion,Phaseshift,Wien-
Bridgeoscillator,Crystalcontrolledoscillator

Unit-3

DigitalCircuits
:Logicfundamentals,Booleantheorem,logicgates:AND,OR,NOT,NOR,NANDXOR, and
EXNOR.RTL, DTL and TTLlogic, Flip-flop, RS-and JK-Flipflop, A/D and D/AConvertors

Unit-4

OptoelectricsDevice:

Principle of optical sources, Source material, Choice of materials, Internal and external quantumefficiencyof L.E.D.,Structures,Typesof L.E.D.:SurfaceemittingL.E.D., EdgeemittingL.E.D.,Modulationcapability,emissionpattern,powerbandwidth product,laserDiodeModes,Thresholdcondition, resonantfrequency,LaserDiode Structure,Brief descriptionofprincipleofopticaldetectors,PhotomultipliersP.I.N.andA.P.D.configuration,Solar Cell.

Textbooksand readingmaterials

1. ElectronicfundamentalandapplicationbyJ.D.Ryder,PHI,LearningPvtLtd.
2. Electronics:CircuitsandAnalysis,D.C.Dubey,AlphaScience
3. R.P.Khare,FiberOpticsand Optoelectronics,Oxford UniversityPress

ReferenceBooks:

1. Foundationofelectronics–Chattopadhyay, Rakshit,SahaandPurkait,NewageInternationalpublisher
2. Electronicsprinciples-AlbertMalvino,TataMcGraw-HillEdition
3. ModernDigitalElectronics-R.PJain,TataMc Graw-HillEdition

Laboratory: **Optics and Modern Physics Lab**

(4credit

)Themainobjectivesofthislaboratorycourseare:

1. Toapplytheprinciplesofoptics,electronics,andmodernphysicsinconductingexperiments.
2. Togainabetterunderstandingoftheoreticalprinciplesthroughhands-onexperimentation.

N.B
:Followingisthelistofsomeexperimenthowever,thecollegecanaddanyotherexperimentsas pertheconvince.

Optics&ModernPhysics:

1. DeterminationofBoltzmannconstantusingV-IcharacteristicsofPNdiode.
2. DeterminationofPlanck'sconstantusingLEDsatleastfourcolors.
3. Determinationofe/mbyBarmagnet/magneticfocussung
4. Studyofphoto-electriceffect.
5. Studyofdiffractionpatternofsingleanddoubleslitsusinglasersourceanddeterminat ionofitswavelength.
6. Studytheelectricalresistanceasafunctionoftemperature.
7. ExperimentswithMichelsoninterferometer:DeterminationofAandαThicknessofmicasheet

8. Fabry Perot interferometer Polarization Experiments Babinet compensatorEdsar-ButlerbandsQuarterwaveplateMallusLawStudyofellipticalpolarizedlight
9. ConstantDeviationSpectrographyCalibrationZeemaneffect
10. BabinetQuartzSpectrography
11. Anyothersuitableexperiments
12. Anyotherexperimentsthatmaybesetupfromtimetotime.

ReferenceBooks:

1. ElementsofModernPhysics:Laboratory(BPHEL-142,
Preparedby:Ignou: school ofscience (https://egyankosh.ac.in)
2. ModernPhysicsLab(PHYS340)
Preparedby:PurdueUniversity,(https://www.physics.putrdue.edu)

FourYearHons.WithReaserch

Sem-VII

Classical
Mechanics
Unit-1

KINEMATICSOF RIGIDBODY MOTION:

Independentcoordinatesofarigidbody,Orthogonaltransformations,Eulerianangles,infinitesimal rotations, rate of change of vector, Coriolis force, angular momentum and kineticenergy of motion about a point, inertial tensor and the moment of inertia, Eigen values of Inertialtensor and the principal axis transformation, methods of solving rigid body problems and Euler'sequationsof motion,torquefree motion of a rigid body. Heavy symmetrical top with one pointfixed.

Unit-2

HAMILTONIANFORMULATION: CalculusofVariationsandEuler-Lagrange'sEquation, BrachistochroneProblem,Hamilton'sPrinciple,Extensionof Hamilton'sPrincipleto Nonholonomic Systems, Legendre Transformation and the Hamilton Equations of Motion,PhysicalSignificanceof

Hamiltonian,Derivationo
fHamilton'sEquationsofMotionfromaVariationalPrinciple,Routh'sProcedure,Principleof
LeastAction

Unit-3

CANONICALTRANSFORMATIONS : CanonicalTransformation,TypesofGeneratingFunction,

conditions for canonical transformation, Integral Invariance of Poincare, Poisson Bracket, Poisson'sTheorem, LagrangeBracket,PoissonandLagrangeBracketsasCanonicalInvariant ,InfinitesimalCanonicaltransformationandConservationTheorems,Liouville'sTheoremHamiltonJaco bi Theory:Hamilton-Jacobi EquationforHamilton's PrincipalFunction,HarmonicOscillatorand Kepler problembyHamilton-Jacobi Method,Action-Angle VariablesforcompletelySeparableSystem,KeplerProbleminAction-AngleVariables

Unit-4

SMALLOSCILLATION: ProblemofSmallOscillations,Exampleoflinear triatomicmoleculeand two coupled Oscillator, General Theory of Small Oscillations, Normal Coordinates andNormalModesof

Vibration.

TestBooks:

1. ClassicalMechanics-byH.Goldstein(Addison-Wesley)

Referencebooks:

1. ClassicalMechanicsbyS.N.Biswas,BooksandAlliedPublisherLtd.
2. ClassicalMechanicsbyJ.C.Upadhay,HimalayaPublishingHouse.
3. ClassicalMechanicsbyLandauandLiftshitz(ButterWorth)

QUANTUMMECHANICS

Unit-1

GENERALPRINCIPLESOFQUANTUMMECHANICS:

A-PostulatesofQuantumMechanicsandmeaningofmeasurement,Operatorsandtheir expectationvalues,Schrodinger equation, Particle in a box, Orthogonality of eigenfunctions.Dirac Notations,Linearvectorspace,KetandBravectors,,Diracdeltafunction,linearoperators,Adjointoperators,Unitary

Operators,Hermitianoperators,Eigenvaluesandeigenvectors, orthonormality of eigen vectors,probabilityinterpretation,Degeneracy,.

B-QUANTUMDYNAMICS:

Time evolution of quantum states,Timeevolutionoperatorandits properties,Schrödinger, Heisenbergand Interaction picture, Equations of motion, Operator methodsolution of Harmonic oscillator problem,Matrixrepresentationandtimeevolutionofcreationandannihilationoperators.

Unit-2

ROTATIONANDORBITALANGULARMOMENTUM:

A-Orbitalangularmomentumoperatorsasgeneratorsofrotation,Lx,Ly,LzandL^{2}andtheirCommutation relations, Raising and Lowering operators (L+and L-),Lx, Ly,Lzand L^{2}in sphericalPolarcoordinates,EigenvaluesandEigenfunctionsofLzandL^2(operatormethod), MatrixrepresentationofLx,Ly,LzandL^2.

B-SPINANGULARMOMENTUM:

Spin ½ particles, Pauli spin matrices and their properties, Eigen values and Eigen functions, Spin androtations. Totalangular momentum: Totalangular momentum J, Eigen value problem of Jz and J^2,Angular momentum matrices, Addition of angular momentum and C. G.coefficients for the states with (i)j_1=½andj_2=½(ii)j_1=1andj_2=½.

Unit-3

A-Motion in a spherically symmetric field: The hydrogen atom, **Approximatemethods:**Stationaryperturbation theory,RayleighSchrodingermethodfornon-degeneratecase,firstand secondorderperturbation,**Variationalmethod**:GroundState,H-atomOne-DimensionalHarmonicOscillator,**W.K.**

B. method: Connection formulas, Bohr-Sommerfeld quantization rule, **Time-dependent perturbationtheory:**Transitionprobability,constant andharmonic perturbation,FermiGoldenrule.

Unit-4

Scatteringamplitudeandscatteringcrosssection:

Born approximation, application to Coulomb and screened Coulomb, potentials. Partial wave analysis forscattering,opticaltheorem,scatteringfromahardsphere,resonantscatteringfromasquarewellpotential.Elementaryidiaonidenticalparticles.

Textbooks:

1. "QuantumMechanics:ConceptsandApplications"byNouredineZettileJohnWileyandsons.

ReferenceBooks:

1. "QuantumMechanics",L.I.SchiffL.I3rdEd,McGrawHillBookCo.
2. “QuantumMechanics”E.Merzbacher,2ndEd.,John Wiley&Sons.
3. "QuantumPhysics",S.GasiorowiczJohnWiley.
4. "ATextBookofQuantumMechanics"byP.M.Mathews.andVenkatesan,TataMcGrawHill.
5. IntroductiontoQuantumMechanics,byD.J.Griffiths,2ndedition,PearsonPublications

LABORATORY:COMPUTATIONALPHYSICS: 4CREDITS

1. Introductiontotheprogramminglanguage(e.g.C/C++/Fortran/Matlab/ Scilab).Theintroductionisaccompaniedbyexamplesinthefollowinggeneralareas.
   (a) SortingAlgorithms--selectionsort,Quicksortetc.
   (b) Solutionofequation--Newton'smethod,Secantmethodetc.
   (c) Simplenumericalintegratons--Trapezoidalrule,simpson1/3rule.
2. Classicalmechanics(2ndorderODE,initialvalueproblems).Eulermthod,Modified-Euler(predictor-corrector) method, Runge-Kutta method, Leapfrog method,Verlet method, Velocity Verlet method,each with and without velocity dependentdrag terms, harmonic oscillator with damping,forced one,realistic projectilemotionwithairdrag,realisticplanetaryorbitcalculation.
3. Quantum Mechanics (2nd order ODE, boundary value and eigenvalue problems).Shooting methodand Numerov's method,examplesof boundstatescalculationfor1D wells,quantum harmonicoscillators. Eigenvalue probleminmatrixform(finitedimensionalbasis),andexact(Lanczos)diagonalization, Variational calculationwith orthogonal basis states. Time-dependentSchrodingerequation,waveequation.
4. Statistical Mechanics (Stochastic and Monte Carlo Methods). Uniform random number generation,Randon walk and diffusion, Monte Carlo Integration -- advantagein higher dimension, error analysis.Importancesamplinganddetailedbalance.Generationof randomnumbersfromaGaussiandistribution-- BoxMillermethod,usingcentrallimittheorem,Samplingpointsfromarbitrarydistributions-- Metropolissamplingandexamples.

References:

1. ComputationalPhysics,N.J.GiordanoandH.Nakanishi,PearsonPrenticeHall(2006)
2. IntroductiontoComputationalPhysics,PaoTang,CambridgeUniversityPress
3. ComputationalPhysics,S.E.KooninandD.C.Meredith,Addison-WesleyPublishingCompany
4. ComputationalPhysics,J.M.Thijssen,CambridgeUniversityPress

Sem-VIII

ClassicalElectrodynamicsUnit–I

A:Covariantformulationofelectrodynamics:

Lorentztransformation;Scalars,vectorsandTensors;Maxwellsequationsandequationsofcontinuity in terms of Aμ and Jμ; Electromagnetic field tensor and its dual; Covariant form o fMaxwell"sequations;LagrangianforachargedparticleinpresenceofexternalelectromagneticfieldandM axwell'sequationasEuler-Lagrangeequations.

B: TheInhomogeneousWaveequation:

Wave equations for potentials, solution by Fourier analysis, Radiation field, Radiation energy, Hertzpotential,Computationofradiationfields byHertzmethod,electricdipoleradiation, multipole-radiation.

Unit–II

A:**Lienard-Wiechart potential and Field of a uniformly moving electron:** Lienard-Wiechartpotential,Fieldsofachargeinuniformmotion,Directsolutionofthewaveequation,Convectionp otential,Virtualphotonconcept.

B:Waveguides,Propagationofelectromagneticwavesin rectangularwaveguides**.**

Unit–III

RadiationfromAcceleratedCharges:

Radiation from an accelerated charge, Fields of an accelerated charge radiation at low velocity,Caseofvelocityparalleltoacceleration,radiationfromcircularorbits,Radiationwithnorestrictio nsontheaccelerationorvelocity,ClassicalcrosssectionforbremsstrahlunginaCoulombfield,Cherenkovr adiation.

Unit–IV

Radiation,scatteringanddispersion:

Radiativedampingofachargedharmonicoscillator,forcedvibrations,scatteringbyanindividual free electron, scattering by a bound electron, absorption of radiation by an oscillator,equilibriumbetweenanoscillatorandaradiationfield,effectofavolumedistributionofscatters, scatteringfromavolumedistribution,Rayleigh scattering,thedispersionrelation.

TextBook:

1. "ClassicalElectricityandMagnetism"byWolfgangK.H.PanofskyandMelbaPhilips,SecondEdition.

Referencebooks:

1. "ClassicalElectrodynamics",JaksonJD,JohnWiley.
2. 'Introduction toElectrodynamics", GriffithsDJ,PrenticeHall.

Laboratory:OpticsandModernPhysicsLab(4credit)

M.B:Followingisthelistofsomeexperimentshowever,thecollegecanaddanyotherexperimentsasperthe convince.

Optics&ModernPhysics:

1. DeterminationofBoltzmannconstantusingV-IcharacteristicsofPNdiode.
2. DeterminationofPlanck'sconstantusingLEDsatleastfourcolors.
3. Determinationofe/mbyBarmagnet/magneticfocussung
4. Studyofphoto-electriceffect.
5. Studyofdiffractionpatternofsingleanddoubleslitsusinglasersourceanddeterminationofitswavelength.
6. Studythe electricalresistanceasafunction oftemperature. Experiments withMichelsoninterferometer:DeterminationofAandαThicknessofmicasheet
7. FabryPerotinterferometerPolarizationExperimentsBabinetcompensatorEdsar-ButlerbandsQuarterwaveplateMallusLawStudyofellipticalpolarizedlight
8. ConstantDeviationSpectrographyCalibrationZeemaneffect
9. BabinetQuartzSpectrography
10. Anyothersuitableexperiments
11. Anyotherexperimentsthatmaybesetupfromtimetotime.

ReferenceBooks:

1. ElementsofModernPhysics:Laboratory(BPHEL-142, Preparedby:Ignou: school ofscience (https://egyankosh.ac.in)
2. ModernPhysicsLab(PHYS340) Preparedby:PurdueUniversity,(https://www.physics.putrdue.