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

Semester	Subjects
I	Core I - MathematicalPhysics-I
	Core II- Mechanics
II	Core III- Electricity and Magnetism
	Core IV - Mathematical Physics-II
III	Core V- WavesandOptics
	Core VI- Mathematical Physics-III
	Core VII- Thermal Physics
IV	Core VIII- AnalogSystems
	Core IX- Basic Instrumentation
	Core X- Nuclear and Particle Physics
V	Core XI- DigitalSystems
	Core XII- Quantum Mechanics and Applications
	Core XIII- SolidStatePhysics
VI	Core XIV- ElectromagneticTheory
	Core XV- Statistical Mechanics
VII	Core XVI- Mathematical Methods in Physics
	Core XVII- Classical Mechanics
	Core XVIII- QUANTUM MECHANICS
	Core XIX- LABORATORY: COMPUTATIONAL PHYSICS
VIII	Core XX- Classical Electrodynamics
	Core XXI- QUANTUM MECHANICS-II
	Core XXII- Electronics
	Core XXIII- Laboratory: Optics and Modern Physics Lab

PROGRAMME OUTCOMES : B.Sc. PHYSICS

PO1: Acquireadequateknowledgeofthesubject

PO2: Craft a foundation for higher learning

PO3: Beinitiatedintothebasicsofresearch

PO4: Imbibe sound moral and ethical values

PO5: Becomeconsciousofenvironmentalandsocietalresponsibilities

PO6: Attainskillsfor communicationandcareer

PO7: Learntotoleratediverseideasanddifferentpointsofview

PO8: Becomeempoweredtofacethechallengesofthechanginguniverse

PROGRAMME: B.Sc. PHYSICS

Course Outcomes

1. Understandthebasicconceptsofmethodologyofscienceandthefundamentalsof mechanics, propertiesofmatterandelectrodynamics, MathematicalPhysics.
2. UnderstandthetheoreticalbasisofMathematicalPhysics,quantummechanics, relativistic physics,nuclearphysics,optics,spectroscopy,solidstatephysics,astrophysics,statistical physics, photonics and thermodynamics
3. Understandandapplytheconceptsofelectronicsinthedesigningofdifferentanalogand digital circuits
4. Understandthebasicsofcomputerprogrammingandnumericalanalysis
5. Apply and verify theoretical concepts through laboratory experiments

Core I **Semester I**

MathematicalPhysics-I

Course Outcomes

- BasicunderstandingofDifferentialequationsandtheirsolutions,conceptualunderstandingofcalculus.
- Basicunderstandingofvectorcalculusanditsdifferentiation.
- Useofvectorcalculustounderstandvectorintegration. Diracdeltafunctionanditsproperties.
- Understandingoforthogonalcurvilinearcoordinatesanditsapplicationinvectordifferentiation.
- To understand the basic algorithm inapplication tofunctionalalgebraanderror analysis.

Unit I

- **Calculus-I:**Plottingoffunctions,Intuitiveideasofcontinuous,differentiablefunctionsandplottingofcurves,Approximation:Taylorandbinomialseries(statementsonly),FirstOrderDifferentialEquationsand Integrating Factor, Second OrderDifferentialequations:HomogeneousEquationswithconstantcoefficients,Wronskianandgeneralsolution,Statementof existenceandUniquenessTheoremforInitialValue Problems, Particular Integral.

- **Calculus-II:** Calculusoffunctionsofmorethanonevariable:Partialderivatives,exactandinexactdifferentials.Integratingfactorwithsimpleillustration, Constrained MaximizationusingLagrangeMultipliers,

Unit II

- **Vectoralgebra:**Recapitulationof vectors:Propertiesof vectors under rotations.Scalar productanditsinvarianceunderrotations,Vectorproduct,Scalartripleproductandtheirinterpretationintermsofarea and volume respectively,Scalar and Vector fields.

- **Vector Differentiation:**Directionalderivativesand normalderivative,Gradientof ascalarfieldanditsgeometricalinterpretation,Divergenceandcurlofavectorfield,DelandLaplacianoperators,Vector identities.

Unit III

- **Vector Integration:**Ordinary IntegralsofVectors, Multipleintegrals, Jacobian, Notionof infitesimalline,surfaceandvolumeelements,Line,surfaceandvolumeintegralsof Vectorfields,Fluxof avectorfield,Gauss' divergence theorem, Green's andStokes Theorems and theirapplications(no rigorousproofs)
- **Dirac Deltafunctionanditsproperties:**Definitionof Diracdeltafunction.Representationaslimitofa Gaussian function and rectangular function, Properties ofDiracdeltafunction

Unit IV

Orthogonal Curvilinear Coordinates: OrthogonalCurvilinearCoordinates,DerivationofGradient,Divergence,CurlandLaplacianinCartesian,SphericalandCylindricalCoordinateSystems,Comparisonofvelocity and acceleration in cylindrical andsphericalcoordinatesystem.

TextBooks:

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

Reference books:

- ✓ *Mathematical Physics C. Harper (Prentice Hall India)*
- ✓ *ComplexVariable:Schaum'sOutlinesSeries M.Spiegel(2nd Edition, Mc-Graw HillEducation)*
- ✓ *Complexvariables and applications, J.W. Brown and R.V.Churchill*
- ✓ *MathematicalPhysics, SatyaPrakash (SultanChand)*
- ✓ *Mathematical Physics, B. D. Gupta (4th edition, Vikas Publication)*
- ✓ *MathematicalPhysics and Special Relativity, M. Das, P.K.Jena andB.K.Dash(SrikrishnaPrakashan)*
- ✓ *MathematicalPhysics –H.K.Das, Dr. Rama Verma (S. ChandPublishing)*
- ✓ *Mathematical Physics, B.S. Rajput,(PragatiPrakashana*

LAB: Credit-1

Theaimofthis Lab is notjust toteachcomputerprogrammingandnumericalanalysisbuttoemphasizeitsrole insolving problems inPhysics.

- Highlights the use ofcomputational methods to solve physical problems
- Evaluation done noton the programming buton the basisofformulatingthe problem
- Aim at teaching students to constructthe computationalproblemto be solved
- Students can use any one operatingsystemLinuxorMicrosoftWindows

Introduction and Overview: Computer architecture and organization, memoryandInput/output devices.Basicsofscientificcomputing:Binaryanddecimalarithmetic, Floatingpointnumbers,algorithms,Sequence, SelectionandRepetition,singleanddoubleprecisionarithmetic,underflowandoverflowemphasizetheimportanceof making equations in terms ofdimensionless variables, Iterative methods. Algorithm Errorsanderror Analysis:Truncation androundofferrors, Absoluteandrelativeerrors,Floatingpointcomputations.SystematicandRandomErrors, PropagationofErrors, NormalLawofErrors,StandardandProbableError.

Reviewof CandC++Programming: IntroductiontoProgramming,constants, Variables andFundamentals data types,operatorsand Expressions, I/Ostatements, scanfandprintf, cinandcout,Manipulatorsfordataformat-ting, Control statements (decisionmakingandloopingstatements)(If Statement,IfelseStatement, NestedIfstructure,ElseIfStatement,Ternaryoperator, GotoStatement.SwitchStatement. Unconditional and Conditional Looping. While Loop.Do-WhileLoop. FOR Loop. Break and ContinueStatements. Nested Loops),Arrays (1D and 2D)andstrings,userdefinedfunctions,Structuresand Unions, Idea ofclasses and objects.

Programs: Sumandaverageof alistof numbers,largestof agivenlistof numbersanditslocationinthelist, sorting ofnumbers in ascendingdescendingorder,Binarysearch.

Random number generation: Area ofcircle, areaofsquare, volume of sphere, value ofτ.

Reference Books:

- ✓ Introduction to Numerical Analysis,S.S.Sastry,5th Edn., 2012, PHILearningPvt.Ltd.
- ✓ Schaum'sOutlineofProgrammingwithC++.J.Hubbard,2000, McGraw– HillPub.
- ✓ NumericalRecipes in C: The Art of Scientific Computing, W.H.Pressetal, 3rd Edn.2007, Cambridge UniversityPress.
- ✓ AfirstcourseinNumericalMethods, U.M. AscherandC. Greif, 2012, PHILearning.
- ✓ ElementaryNumericalAnalysis,K.E.Atkinson, 3rdEdn. , 2007 ,WileyIndia Edition.
- ✓ NumericalMethodsforScientistsandEngineers,R.W.Hamming,1973,CourierDover Pub.
- ✓ An Introduction tocomputational Physics,T.Pang,2ndEdn.,2006,Cam-bridgeUniv.Press.

Core II

Mechanics

Course Outcomes

- ToLearn thebasic conceptsofRigidbodydynamics,RadiusofGyration,MomentofInertia,Non-InertialSystems
- ToUnderstand the conceptofElasticity,FluidmotionandTypesof Vibration
- Tounderstand the conceptofNewtoniantheorythroughGravitation,Centralforcemotion,Keplar'slaws,GPS
- Tolearn the conceptofSpecialtheoryofRelativity,Michelson-Morleyexperiment,Lorentz transformation,RelativisticDoppler effect.
- Apply thebasicconceptsofMechanicsinexperiments.

Unit I

- **RotationalDynamics:**CentreofMass,MotionofCoM,CentreofMassandLaboratoryframes,Angular momentum of a particle and system ofparticles, Principle of conservation of angularmomentum, Rotationabout a fixed axis,Momentof Inertia,PerpendicularandParallelAxisTheorems, Routh Rule,Calculationofmoment ofinertiafor cylindricalandspherical bodies,Kineticenergyof rotation,Euler'sEquationsof RigidBodymotion,Motioninvolvingboththranslationandrotation. Moment ofInertia ofa Flywheel.
- **Non-Inertial Systems:** Non-inertialframesandfictitiousforces, uniformlyrotatingframe,LawsofPhysics in rotating coordinatesystems, Centrifugal force,Coriolisforce.

Unit II

- **Oscillations**:

  Dampedoscillation.Equationofmotionandsolution(casesofoscillatory,criticallydampedand overdamped)Forcedoscillations:Transientandsteadystates;Resonance,sharpnessof resonance;power dissipationandQualityFactor, BarPendulum, KatersPendulum
- **Elasticity:**RelationbetweenElasticconstants,TwistingtorqueonaCylinderorWire,Bendingofbeams, External bending moment, Flexural rigidity,Single and double cantilever
- **FluidMotion:**Kinematicsof MovingFluids:PoiseuillesEquationforFlowof aLiquidthroughaCapillaryTube,Surface tension, Gravity wavesand ripple
- **Viscosity:** Poiseuilles Equation for Flow ofa Liquid with corrections.

Unit IIIGravitationandCentralForceMotion

Lawofgravitation, Gravitationalpotentialenergy,Inertialandgravitationalmass, Potentialandfielddue tosphericalshellandsolidsphere,Motionof a particleunderacentralforcefield,Two-bodyproblemanditsreductiontoone-bodyproblemanditssolution,DifferentialEquationof motionwithcentralforceanditssolution,ThefirstIntegrals(two),Conceptof powerLawPotentials, Kepler'sLawsofPlanetarymotion, Satellites. Geosynchronousorbits,Weightlessness, Basic idea ofglobal positioning system(GPS).

Unit IV

SpecialTheoryof Relativity: Michelson-Morley Experimentand itsout-come, Postulates ofSpecialTheoryofRelativity,LorentzTransformations,Simultaneityandorderof events,Lorentzcontraction,Time dilation, Relativistic transformation of velocity, Frequency and wave number, Relativisticaddition ofvelocities, Variation ofmass with velocity,MasslessParticles,Mass-energy Equivalence,Relativistic Doppler effect, Relativistic Kinematics, Transformation ofEnergy and Momentum.

Text Books:

- ✓ *Mechanics, D.S. Mathur (S. ChandPublishing)*
- ✓ *Introduction to Special Relativity, R. Resnick (John Wiley)*

Reference Books:

- ✓ *Introduction to Mechanics Daniel Klapnner and Robert Kolenkow, McgrawHill. Mechanics by K.RSimon*
- ✓ *Mechanics, Berkeley Physics, vol.1, C.Kittel, W. Knight, etal (Tata McGraw-Hill)*
- ✓ *Physics, Resnick, Halliday and Walker (8/e.2008,Wiley)*
- ✓ *Theoretical Mechanics-M.R.Spiegel (Tata McGrawHill).*
- ✓ *Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands (Pearson)*
- ✓ *Mechanics-M.Das, P.K.Jena and R.N. Mishra (SrikrishnaPublications)*
- ✓ *Classical Mechanics,GuptaKumar&Sharama,(PragatiPrakashan)*
- ✓ *Classical Mechanics, J.C.Upadhyaya, (Himalaya Publishing Home)*

LAB : Credit 1

(Minimum 4 experimentsaretobedone):

1.To study surfacetensionby capillaryrise method.

2.To determine the height ofa building using aSextant.

3.TostudytheMotion ofSpringandcalculate (a) Spring constant,(b) gand(c) Modulus ofrigidity.

4.To determine the Moment ofInertia ofa Flywheel.

5. TodetermineCoefficientof Viscosityof waterbyCapillaryFlowMethod(Poiseuillesmethod).

6. TodeterminetheModulusofRigidityofaWirebyMaxwell'sneedle.

7.Todetermine the value ofg using Bar Pendulum.

8.Todetermine the value ofg using Kater's Pendulum.

Reference Books:

- ✓ *AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop, 1971, Asia Publishing House.*
- ✓ *Advanced level Physics Practical's, MichaelNelson and Jon M. Ogborn, 4th Edition,reprinted1985, Heinemann Educational Publishers.*
- ✓ *ATextbookofPracticalPhysics,I.PrakashandRamakrishna, 11thEdn,2011,Kitab Mahal.*

Core III

Semester – II

Electricity and Magnetism

Course Outcomes

- Tounderstand thebasicconcepts ofElectricityandMagnetism
- ToUnderstand the variousphenomenainElectricityandMagnetism
- ToUnderstand Circuitanalysisandnetwork theorems
- ToExplain theDynamicsofChargedParticles
- To Apply theacquiredknowledgeinExperiment.

Unit 1 :Electric Field and Electric Potential

- **Electricfield:**Electricfieldlines,Electricflux,GaussLawwithapplicationstochargedistributionswith spherical,cylindricalandplanarsymmetry,Conservativenatureof ElectrostaticField.ElectrostaticPotential,PotentialandElectricFieldofadipole,ForceandTorqueonadipole,Pot entialcalculationindifferentsimplecases,LaplaceandPoissonequations,TheUniquenessTheorem,Metho dof Imagesanditsapplication to (1) Plane Infinite Sheet and (2) Sphere.
- Electrostaticenergyof systemof charges,Electrostaticenergyof achargedsphere,Conductorsinanelectrostatic Field, Surface charge and force on aconductor.

Unit IIMagneticField

- MagneticForce,LorentzForce,BiotSavarts Law,Cur- rentLoopasa Magnetic DipoleanditsDipoleMoment(analogywithElectricDipole),AmperesCircuitalLawanditsapplicationto(1) Solenoid (2) Toroid (3)Helmhotzcoil, Propertiesofcurlanddivergence, VectorPotential,Ballistic Galvanometer: Torque on a current Loop,CurrentandChargeSensitivity,Electromagneticdamping,Logarithmic damping,CDR.

Unit III

Dielectric Properties ofMatter: Electric Field in matter, Polarization, Polarization Charges, ElectricalSusceptibility and Dielectric Constant, Capacitor (parallel plate, spherical,cylindrical)filled withdielectric, Displacement vector D, Relations betweenE,Pand D,GaussLawindielectrics.MagneticPropertiesof Matter: Magnetization vector (M), MagneticIntensity(H),MagneticSusceptibilityandpermeability,RelationbetweenB,H,M,Ferromagnetism ,B-Hcurveandhysteresis.Electromagnetic Induction:FaradaysLaw,Lenz'sLaw,Self - InductanceandMutualInductance,ReciprocityTheorem,Energy stored in a Magnetic Field, Introduction to Maxwell's Equations.

Unit IV

- **ElectricalCircuits:**ACCircuits:KirchhoffslawsforACcircuits,ComplexReactanceandImpedance,Series
- **LCR Circuit:** (1) Resonance (2) Power Dissipation (3)QualityFactor,(4)BandWidth,ParallelLCRCircuit.
- **Network theorems:** Kirchoff's law for electrical circuits, Ideal Constant-voltage andConstant-current Sources.
- **Network Theorems:** Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem,MaximumPowerTransfertheorem,ApplicationstoDCcircuits.TransientCurrentsGrowthanddecay ofcurrent in RCand LRcircuits.

Text Books:

- ✓ *Introductionto Electrodynamics–D.J. Griffiths (Pearson,4th edition, 2015)*
- ✓ *FoundationsofElectromagneticTheory-RitzandMilford (Pearson*)

Reference Books:

- ✓ *Classical Electrodynamics, J. D. Jackson (Wiley).*
- ✓ *Electricity and Magnetism D. C. Tayal (Himalaya Publishing house)*
- ✓ *Electricity, Magnetism and Electromagnetic Theory- S. Mahajan and Choudhury(Tata McGraw Hill)*
- ✓ *FeynmanLecturesVol.2, R. P. Feynman, R. B. Leighton, M. Sands(Pearson)*
- ✓ *Electricityand Magnetism,J.H.FewkesandJ. Yarwood. Vol.I(OxfordUniv.Press)*
- ✓ *Classical Electromagnetism, H.C.Verma, BharatiBhawan*

LAB: Credit-1
(Minimumof 6 experiments are to bedone)

UseaMultimeterformeasuring (a) Resistances, (b) ACandDCVoltages,
c)DCCurrent, (d) Capacitances, and (e) Checking electrical fuses.

1. To study the characteristicsofaseries RCCircuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey FostersBridge.
4. To compare capacitances using DeSauty's bridge.
5. Measurement offield strength B and its variationinasolenoid(determinedB/dx)
6. To verify the Thevenin and Norton theorems.
7. To determine self-inductance ofa coil by Andersonsbridge.
8. Tostudy responsecurveof aSeriesLCR circuitanddetermineits(a) Reso- nantfrequency,(b)Impedance at resonance, (c) Quality factor Q,and(d)Bandwidth.
9. To study the response curve ofa parallel LCRcircuitanddetermineits(a)
10. Anti-resonance frequency and (b)QualityfactorQ.

Reference Books:

- ✓ AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop, 1971,Asia
- ✓ Publishing House
- ✓ A TextBookof PracticalPhysics,I.PrakashandRamakrishna,11thEd.,2011,KitabMahal
- ✓ AdvancedlevelPhysicsPracticals,MichaelNelsonandJonM.Ogborn, 4thEdition, reprinted1985, Heinemann Educational Publishers
- ✓ ALaboratoryManualofPhysicsforundergraduateclasses,D.P.Khandelwal,1985, VaniPub.

Core IV

Mathematical Physics-II: Credit-3

The emphasis ofthe course is on applications in solving problems ofinterest tophysicists.Students areto be examined on the basis ofproblems,seen andunseen.

Course Outcomes

- Conceptual understanding ofFourierseriesanditsapplicationin periodicfunction.
- Understanding the various specialfunctionsandits properties.
- Understanding various polynomials andspecial integrations.
- To learn theapplicationsofpartialdifferentialequation.
- Toapply theacquired knowledge tosolveproblems.

Unit I FourierSeries- I

Periodicfunctions, Orthogonalityofsineandcosinefunctions, DirichletConditions (Statementonly),Expansionofperiodicfunctionsinaseriesofsineandcosinefunctionsand determinationofFouriercoefficients,ComplexrepresentationofFourierseries,Expansionoffunctionswitharbitrary period,Expansionof non-periodicfunctionsoveraninterval,EvenandoddfunctionsandtheirFourierexpansionsandApplication,SummingofInfiniteSeries,Term-by-Termdifferentiationandintegration ofFourierSeries, Parseval Identity.

Unit IIFrobeniusMethod and Special Functions

Singular Points ofSecond Order Linear DifferentialEquations and their importance, Singularities ofBessel's and Laguerre Equations, Frobeniusmethodanditsapplicationstodifferentialequations:Bessel,LegendreandHermiteDifferentialEquations, Legendre and Hermite Polynomials: Rodrigues Formula, Generating Function,Orthogonality

Unit III

- **Polynomials:**Simple recurrence relationsof Legendreand HermitePolynomials, Expansionof functioninaseriesof Legendre Polynomials, AssociatedLegendreDifferentialEquation,AssociatedLegendrepolynomials, Spherical Harmonics.Spherical Bessel's Function ($1^{st}$and 2^{nd}kind).

- **Some SpecialIntegrals:**Beta and GammaFunctions andrelationbetweenthem,ExpressionofIntegrals in terms ofGamma Functions, Error Function (Probability Integral).

Unit IVPartial Differential Equations

Solutions topartialdifferential equations usingseparationofvariables: Laplace's Equationin problemsof rectangular, cylindricalandsphericalsymmetry.Conducting and dielectricsphere in anexternal uniformelectricfield.Waveequationanditssolutionfor vibrational modes ofa stretchedstring.

Text Books:

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

Reference Books:

- ✓ *Mathematical Physics and Special Relativity, M. Das, P.K. Jena and B.K. Dash(SrikrishnaPrakashan)*
- ✓ *Mathematical Physics–H. K. Dass, Dr. Rama Verma (S. Chand Publishing)*
- ✓ *Mathematical Physics C. Harper (Prentice Hall India)*
- ✓ *ComplexVariable:Schaum'sOutlinesSeriesM. Spiegel (2ndEdition, McGrawHill Education)*
- ✓ *Complex variables and applications J.W.Brown and R.V.Churchill*
- ✓ *MathematicalPhysics, SatyaPrakash (Sultan Chand)*
- ✓ *Mathematical Physics B. D. Gupta (4th edition, Vikas Publication)*
- ✓ *MathematicalPhysics, B.S.Rajput, PragatiPrakashan*

LAB: Credit 1

Theaimof thisLabis to use thecomputational methods tosolvephysicalproblems.Coursewillconsistof lectures(both theoryand practical) in the Lab.Evaluationdonenotontheprogrammingbutonthebasisofformulating the problem.

Topics

IntroductiontoNumericalcomputationsoftwareScilab: Introductionto Scilab, Advantages anddisadvantages,Scilabcomputationsoftware Scilabenvironment,Commandwindow,Figurewindow,Editwindow,Variablesandarrays,InitialisingvariablesinScilab,Multidimensionalarrays,Subarray,Specialvalues,Displayingoutputdata,datafile,Scalarandarrayoperations,Hierarchyofoperations,BuiltinScilabfunctions, Introductiontoplotting, 2Dand3Dplotting(2),

BranchingStatements and program design, Relational and logical operators,thewhileloop,forloop,detailsof loopoperations,breakandcontinuestatements,nestedloops,logicalarraysandvectorization(2)User definedfunctions, IntroductiontoScilabfunctions, VariablepassinginScilab, optionalarguments,preservingdata betweencalls toafunction,ComplexandCharacter data,stringfunction, Multidimensional arrays (2) anintroductiontoScilabfileprocessing,fileopeningandclosing,BinaryI/ofunctions,comparingbinaryandformattedfunctions, Numericalmethodsanddevelopingtheskillsofwritinga program(2).

Curve fitting, Least squarefitGoodnessof fit,standardconstantDeviation: Ohmslawtocalculate R, Hookes law to calculate spring constant

Solution of Linearsystemof equations byGauss eliminationSolution methodandGaussSeidalmethod.Diagonalizationmatrices,Inverseofamatrix,Eigenvectors,problems: Solutionofmesh equations ofelectric circuits (3meshes), Solution ofcoupledspring masssystems (3meshes).

SolutionofODEFirstorderDifferentialequationEuler, modiftedEulerRunge-Kuttasecondmethods Secondorderdifferentialequation. Fixeddifferencemethod:

First order diferential equation

- •Radioactivedecay
- • Current in RC, LC circuits with DCsource
- • Newtonslawofcooling
- •Classical equations ofmotion

Second orderDifferentialEquation

- • Harmonicoscillator (nofriction)
- • Damped Harmonicoscillator

•Overdamped
•Critical damped
•Oscillatory
• ForcedHarmonicoscillator
• Transient andSteady statesolution
• ApplyabovetoLCRcircuitsalso

Reference Books:

- ✓ *MathematicalMethodsforPhysicsandEngineers,K.FRiley,M.P.HobsonandS.J.20 Bence, 3rd ed., 2006, Cambridge UniversityPress.*
- ✓ *ComplexVariables, A.S.FokasandM.J.Ablowitz, 8thEd.,2011,Cambridge Univ. Press.*
- ✓ *Firstcourseincomplexanalysiswithapplications,D.G.ZillandP.D.Shana-han,1940,Jones and Bartlett.*
- ✓ *Simulation ofODE/PDE Models with MATLAB, OCTAVE andSCILAB:ScientificandEngineeringApplications:A.V.Wouwer, P. Saucez, C.V. Fern- ndez. 2014Springer.*
- ✓ *Scilabbyexample: M. Affouf2012, ISBN: 978-1479203444*
- ✓ *Scilab (AfreesoftwaretoMatlab):H.Ramchandran,A.S.Nair.2011S.Chand andCompany*
- ✓ *ScilabImageProcessing: LambertM. Surhone. 2010 BetascriptPublishing*

Core V **Semester III**

WavesandOptics

Course Outcomes

- Basicunderstanding ofpropagation oflight, its application and wave nature.
- To Understand the concepts ofwave motion.
- To Understand the concepts ofinterference and its application.
- To Understand the concepts ofdiffraction and its application.
- ToApplytheacquiredknowledgeofopticsinExperiment

Unit I

Geometricaloptics:Fermat's principle,reflectionandrefractionatplaneinterface,MatrixformulationofgeometricalOptics,CardinalpointsandCardinalplanesofanopticalsystem,Ideaofdispersion,ApplicationtothickLensandthinLens,RamsdenandHuygenseyepiece.Wave Optics: Electromagneticnature oflight. Definition and properties ofwave frontHuygensPrinciple.TemporalandSpatialCoherence.

Unit II

WaveMotion: PlaneandSphericalWaves, LongitudinalandTransverseWaves, PlaneProgressive (Traveling)Waves,WaveEquation,ParticleandWaveVelocities,DifferentialEquation,PressureofaLongitudinal Wave, EnergyTrans- port,Intensityof Wave.Superpositionof twoperpendicularHarmonic Oscillations:GraphicalandAnalyticalMethods, LissajousFigures (1:1 and 1:2) andtheiruses,Superposition ofHarmonic waves.

Unit III

Interference: Divisionofamplitudeandwavefront,Young'sdoubleslitexperiment,LloydsMirrorandFresnelsBiprism,Phasechangeon reflection:Stokestreatment,InterferenceinThinFilms:parallelandwedge-shapedfilms,Fringesofequalinclination(HaidingerFringes),Fringesof equalthickness(FizeauFringes), Newton'sRings:Measurementof wavelengthandrefractiveindex.Interferometer:Michelson's Interferometer-(1)Ideaofformoffringes(Notheoryrequired),(2)DeterminationofWavelength, (3) WavelengthDifference, (4) RefractiveIndex, and(5) Visibilityoffringes, Fabry-Perotinterferometer.

Unit IV

Fraunhofferdiffraction: Singleslit, Circularaperture, ResolvingPowerofatelescope, Doubleslit,Multipleslits, Diffractiongrating, Resolving powerof grating. Fresnel Diffraction:Fresnel'sAssumptions,Fresnel'sHalf-PeriodZonesfor PlaneWave,Explanationof Rectilinear

Propagationof Light,Theoryof aZonePlate:MultipleFociof aZonePlate,Fresnel'sIntegral,Fresneldiffractionpatternof astraightedge, aslitandawire.

.

TextBooks:

- ✓ *AtextbookofOpticsN.SubhramanyamandBrijLal (S.ChandPublishing)*
- ✓ *Optics - AjoyGhatak (McGrawHill)*

Reference Books

- ✓ *Optics-E. Hecht(Pearson)*
- ✓ *FundamentalsofOptics-F. A. JenkinsandH. E.White(McGraw-Hill)*
- ✓ *Geometrical and Physical Optics R.S. Longhurst (Orient Blackswan)*
- ✓ *ThePhysicsofVibrationsandWaves- H. J.Pain(JohnWiley)*
- ✓ Optics P. K. Chakraborty.
- ✓ Principles ofOptics-Max Born and Emil Wolf(PergamonPress)
- ✓ ThePhysicsofWavesandOscillations-N. K. Bajaj(McGrawHill)

LAB: Credit-1

(Minimum 5 experiments are to bedone)

1. Todeterminethefrequencyofanelectrictuningforkby Melde' sexperimentandverify2-Tlaw.
2. To plot the I-D curve andtodeterminethe refractiveindexofaprism
3. To determine refractive index ofthe Materialofa prismusingsodiumsource.
4. To determine the dispersive power andCauchyconstantsofthe materialofa prismusingmercurysource.
5. TodeterminewavelengthofsodiumlightusingNewton' sRings.
6. Todeterminewavelengthof(1)Nasourceand(2)spectrallinesofHgsourceusingplanediffractiongrating.
7. To determine dispersive power and resolving power ofa planediffractiongrating.

Reference Books:

- ✓ AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop, 1971,Asia Publishing House
- ✓ AText Bookof Practical Physics,I. Prakash and Ramakrishna,11thEd.,2011,Kitab Mahal
- ✓ AdvancedlevelPhysicsPracticals,MichaelNelsonandJonM.Ogborn, 4thEdition, reprinted1985, Heinemann Educational Publishers
- ✓ ALaboratoryManualofPhysicsforundergraduateclasses, D. P.Khandelwal, 1985,Vani

Core VI

Mathematical Physics-III

Course Outcomes

- Understanding and application ofComplex function variables.
- Understanding the concept ofFourier Integral transform.
- To Understand the properties and application ofFourier integral transformation.
- To Understand the properties and application ofLaplace integral transformation.
- To Apply the acquired knowledge to solve problems.

Unit I

- **ComplexAnalysis:** BriefRevisionofComplexNumbersandtheirGraphicalRepresentationEuler's
- formula,DeMoivrestheorem,Rootsof complexNumbers,Functionsof ComplexVariables,AnalyticityandCauchy-RiemannConditions,Examplesofanalyticfunctions,Singularfunctions:polesandbranchpoints, order of singularity,branchcuts,Integrationof afunctionof acomplexvariable,CauchysInequality,CauchysIntegralformula,Simplyandmultiplyconnectedregion,LaurentandTaylorsexpansion, Residues and Residue Theorem, Application insolvingDefiniteIntegrals.

Unit II

- **Integral Transforms-I:** Fourier Transforms: Fourier Integral theorem, FourierTransform,Examples,Fourier Transform oftrigonometric, Gaussian, finite wave trainandotherfunctions,RepresentationofDirac delta function as a Fourier Integral, Fourier transformofderivatives,Inverse FourierTransform.

Unit III

- **Integral Transforms-II:** Convolution theorem, Propertiesof Fourier Transforms(translation,changeof scale,complexconjugation),ThreedimensionalFourier transformswith examples,Application ofFourier Transforms to differential equations: One dimensional Wave and Diffusion/Heatflow Equations.

Unit IV

- **Laplace Transforms:** Laplace Transforms (LT) ofElementary functions,

- **Propertiesof LaplaceTransforms:**Changeof ScaleTheorem,ShiftingTheorem, LTsof DerivativesandIntegrals ofFunctions, Derivatives and IntegralsofFunctions, DerivativesandIntegralsofLTs.LTofUnitStepfunction,DiracDeltafunction,PeriodicFunctions,Inverse LT,Applicationof LaplaceTransformstoDifferential Equations: Damped Harmonic Oscillator,Simple ElectricalCircuits.

Text Books:

- ✓ *MathematicalMethodsforPhysicists, G.B.Arfken, H.J.Weber, F.E.Harris(2013,7thEdn.,Elsevier)*
- ✓ *Advanced Engineering Mathematics, ErwinKreyszig (WileyIndia)*

Reference Books:

- ✓ *MathematicalPhysicsandSpecialRelativity–M.Das,P.K.JenaandB.K. Dash(SrikrishnaPrakashan)*
- ✓ *MathematicalPhysics–H.K. Dass,Dr.Rama Verma (S. Chand Publishing)*
- ✓ *Mathematical Physics C. Harper (Prentice Hall India)*
- ✓ *Complex•Variable:Schaum'sOutlinesSeriesM.Spiegel(2ndEdition,Mc-GrawHill Education)*
- ✓ *Complex variables and applications J.W.Brown and R.V.Churchill*
- ✓ *MathematicalPhysics, SatyaPrakash (Sultan Chand)*
- ✓ *Mathematical Physics B.D.Gupta (4thedition,VikasPublication)*
- ✓ *Mathematical Physics B.S.Rajput, PragatiPrakashan*
- ✓ *Mathematical physics-III,(UniversityPhysics),Dr.RanjanKumarBhuyan,HimalayaPublishing House*

LAB: Credit-1

Scilab based simulations (XCos) experiments based on Mathematical Physics problems like

.Solve simple differentialequationslike:

$\frac{dy}{dx}$=e^{-x}wit□ y(x=0)=0

$\frac{dy}{dx}$+e^{-x}=x^{2}wit□ y(x=0)=0

$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} = -y$wit□ y(x=0)=0, y$'$(x=0)=1$\frac{d^2y}{dx^2}$+e^{-x}

$\frac{dy}{dx} = -y$wit□ y(x=0)=0, y$'$(x=0)=1

.Direct Delta Function:

Evaluate$\int_{-3}^{3} dx \frac{x=3}{\sqrt{2\pi a^2}}\ e^{-\frac{(x-2)^2}{4a^2}}$, for σ =0.1,0.01,0.001andshowthatittendsto5.

.FourierSeries:

Program to sum; evaluate the Fourier Coefficients of a given periodic function(SquareWave)

.Frobenius Method andSpecial Functions:

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

PlotPn(x), Legendrepolynomialofdegreen, andJn(x),Besselfunctionoffirstkind.Show Recursion relation.

- Calculationoferrorforeachdatapointofobservationsrecordedinexperimentsdoneinprevious semesters (chooseanytwo)
- Calculationof leastsquarefitting manually withoutgivingweightagetoerror.Confirmationof leastsquare fitting ofdata throughcomputer Programme.
- Evaluationof trigonometricfunctionse.g.SinΘ,GivenBessel'sfunctionat Npoints,finditsvalueat anintermediate point.

Complex analysis: Calculate $\int \frac{dx}{x^2+2}$ and check it with computerintegration.

Integraltransform: FFTofe$^{-x^2}$

Reference Books:

- ✓ *MathematicalMethodsforPhysicsandEngineers, K.FRiley,M.P.HobsonandS.J.Bence, 3rd ed., 2006, Cambridge UniversityPress.*
- ✓ *MathematicsforPhysicists, P.DenneryandA.Krzywicki,1967, DoverPublications.*
- ✓ *Simulation ofODE/PDE Models with MATLAB, OCTAVEandSCILAB:Scientific andEngineeringApplications:A.VandeWouwer,P.Saucez,C.V.Fernndez.2014 SpringerISBN: 978-3319067896*
- ✓ *Scilabbyexample: M. Affouf, 2012. ISBN: 978-1479203444*
- ✓ *Scilab (AfreesoftwaretoMatlab): H.Ramchandran, A.S.Nair.2011 S.ChandAndCompany, ScilabImageProcessing:LambertM. Surhone.2010Betascript Publis*hing.

Core VII

Thermal Physics

Course Outcomes

- Basicunderstanding ofthermodynamics andvarious thermal variables.
- Understanding various thermodynamics potential applications and theirproperties.
- To Understand the concepts ofideal gas and its thermalproperties.
- To Understand the concepts ofreal gas and its thermalproperties.
- ToApplytheacquiredknowledgeofthermodynamicsinExperiments

Unit I

- **IntroductiontoThermodynamics**Recapitulation ofZeroth and First law ofthermodynamics,
- **SecondLawof Thermodynamics:**ReversibleandIrreversibleprocesswithexamples, Kelvin-PlanckandClausius StatementsandtheirEquivalence, Carnot'sTheorem, ApplicationsofSecondLawofThermodynamics:ThermodynamicScale ofTemperature and its Equivalence to Perfect Gas Scale.
- **Entropy:**Conceptof Entropy,ClausiusTheorem.ClausiusInequality, SecondLawof Thermodynamicsin terms ofEntropy, Entropy ofa perfect gas, Principle ofincreaseof Entropy,EntropyChangesinReversibleandIrreversibleprocesseswithexamples,EntropyofthePrinciple ofIncrease ofEntropy, TemperatureEntropy diagrams for Carnot's Cycle,ThirdLaw ofThermodynamics, Unattainability ofAbsolute Zero.

Unit II

- **Thermodynamic Potentials:** Extensive and Intensive Thermodynamic Variables. Internal Energy,Enthalpy,HelmholtzFreeEnergy,GibbsFreeEnergy,TheirDefinitions,PropertiesandApplications,Sur faceFilms and Variation of Surface Tension with Temperature, Magnetic Work, Cooling due to adiabaticdemagnetization.
- **Phase Transitions:**Firstand secondorderPhaseTransitionswith examples, Clausius ClapeyronEquation and Ehrenfest equations.
- **MaxwellsThermodynamicRelations:**Derivations andapplications ofMaxwells Relations, Maxwells
- Relations: (1) ClausiusClapeyronequation(2)RelationbetweenC_p andC_v (3)TdSEquations,(4)Joule-KelvincoefficientforIdealand.
  VanderWaalGases(5)Energyequations(6)ChangeofTemperatureduring Adiabatic Process.

Unit III

- **Kinetic Theory ofGases**
- **Distributionof Velocities:**Maxwell-BoltzmannLawof Distributionof VelocitiesinanIdealGasandits ExperimentalVerification, SternsExperiment,Mean,RMSandMostProbableSpeeds, Degreesof Freedom, Law ofEquipartition ofEnergy (No proofrequired),Specific heatsofGases.
- **Molecular Collisions:** Mean Free Path, Collision Probability, Estimates ofMean Free Path,
- **Transport Phenomenon in Ideal Gases:** (1)Viscosity,(2)Thermal Conductivity and(3)Diffusion.Brownian Motion and itsSignificance.

Unit IV

RealGases: BehaviorofRealGases: DeviationsfromtheIdealGasEquation,TheVirialEquation,AndrewsExperimentsonCO2Gas.CriticalConstants,Continuityof LiquidandGaseous State.Vapourand Gas, Boyle Temperature, Van derWaalsEquationof Statefor RealGases, ValuesofCriticalConstants,Lawof CorrespondingStates,ComparisonwithExperimentalCurves,P-VDiagrams,JoulesExperiment,FreeAdiabaticExpansionofaPerfectGas,Joule-ThomsonPorousPlugExperiment,Joule- ThomsonEffect for Real and Van der WaalGases,TemperatureofInversion,Joule-ThomsonCooling.

Text Books:

- ✓ *ThermalPhysics,A. B. Gupta (BooksandalliedLtd)*
- ✓ *Heat and Thermodynamics,M.W.Zemansky,Richard Dittman (McGraw- Hill)*

Reference Books:

- ✓ Theoryandexperimentsonthermal Physics,P.K.Chakrabarty(Newcen-tralbook agency limited)
- ✓ Thermodynamics,KineticTheoryandStatisticalThermodynamics-SearsandSalinger (Narosa)
- ✓ ATreatise on Heat- MeghnadSaha and B.N.Srivastava(The IndianPress)Heat,andthermodynamics and Statistical Physics, N.SubrahmanyamandBrijLal (S.Chand Publishing)
- ✓ *ThermalandStatisticalPhysicsM.Das,P.K.Jena,S.Mishra,R.N.Mishra(Shri Krishna Publication)*
- ✓ *Heat, Thermodynamicsand statistical physics, Brijlal, Subhramanyam andHemne,S.Chand Publication.*

LAB: Credit-1

(Minimum 5 experiments are to be done)

1.To determine Mechanical Equivalent ofHeat, J, by Callender and Barnesconstantflowmethod.

2.To determine the Coefficient ofThermal Conductivity ofa bad conductor by Leeand Charltons discmethod.

3.To determine the Temperature Coefficient ofResistance by PlatinumResistanceThermometer (PRT).

4.Tostudy the variation of Thermo-Emf of aThermocouplewithDifferenceofTemperature ofits Two Junctions.

5.Todetermine J by Caloriemeter.

6.To determine thespecific heat ofliquid by the methodofcooling.

7.To determine thespecific heat of solid by applying radiationofcorrection.

Reference Books:

- ✓ *AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop, 1971,Asia Publishing House*
- ✓ *AText Bookof PracticalPhysics,I.PrakashandRamakrishna,11thEd.,2011,KitabMahal*
- ✓ *AdvancedlevelPhysicsPracticals,MichaelNelsonandJonM.Ogborn, 4thEdition, reprinted1985, Heinemann Educational Publishers*
- ✓ *ALaboratoryManualofPhysicsforundergraduateclasses,D.P.Khandelwal,1985,VaniPub.*

Core VIII **Semester IV**

AnalogSystems

Course Outcomes

- Basic understanding ofsemiconductor diodes, devices and theirapplications.
- To understand the basic concepts in transistors andamplifiers.
- To understandthe conceptofcoupledamplifieranditsapplicationinfeedbackcircuit.
- To understand the concepts ofoperational amplifier anditsapplication.
- To apply the acquired knowledge ofelectronic circuits inExperiments.

Unit 1

- **SemiconductorDiodes:**PandNtypesemiconductors,energyleveldiagram,conductivityandMobility,Conceptof Driftvelocity,PN junctionfabrication(simpleidea),BarrierformationinPNJunctionDiode,StaticandDynamicResistance,CurrentflowmechanisminForwardandReverseBiasedDiode,Driftvelocity, derivation for Barrier Potential, Barrier WidthandcurrentStepJunction.
- **Twoterminaldeviceandtheirapplications:**(1)Rectifier Diode: Half-waveRectifiers.center-tappedandbridgetypeFull-waveRectifiers,Calculationof RippleFactorandRectificationEfficiency, L and C Filters (2) Zener Diode andVoltageRegulation,PrincipleandstructureofLEDS,(2) Photo diode(3)Solar Cell.

Unit II

- **BipolarJunctionTransistors:** n-p-nandp-n-ptransistors,CharacteristicsofCB, CEandCCConfigurations,Currentgainsaandb,Relationbetweena andb,Loadline analysisof Transistors,DC LoadlineandQ-point, Physicalmechanismofcurrentflow, Active,Cut-offandSaturationRegions.
- **TransistorsBiasing:**TransistorBiasingandStabilizationcircuits,FixedBias andVoltageDividerBias.
- **Amplifiers:**Transistorsas2-portnetworkh-parameterEquivalentCircuit,AnalysisofasinglestageCEamplifier using Hybrid Model, Input and Outputimpedance,Current, VoltageandPower Gains.

Unit III

- Classification ofclass A, B and C amplifiers, Push-pullamplifier(classB).
- **Coupled Amplifier:** RC-coupled amplifier and its frequency response.
- **FeedbackinAmplifiers:**EffectofPositiveandNegativeFeedbackonIn- putImpedance, Output Impedance,GainStability,DistortionandNoise.SinusoidalOscillations:Barkhausenscriterianforself-sustainedoscillations.RCPhaseshiftoscillator,determinationof Frequency,HartleyandColpittsoscillators.

Unit IV

- **Operational Amplifiers(Black Boxapproach):**CharacteristicsofanIdealandPracticalOP-AMP(IC741).Open-loopandClosedloopGain.FrequencyResponse.CMRR,SlewRateandconceptofvirtual ground.
- **Applicationsof Op-Amps:**(1)Invertingandnon-invertingamplifiers(2)Adder(3)Subtractor (4)Differentiator,(5)Integrator(6) Log amplifier, (7) Zero crossing detector (8) Weinbridgeoscillator.

Text Books

- ✓ *Foundationsof Electronics-RaskhitandChattopadhyay(NewageInternational Publication)*
- ✓ *ConceptofElectronics- D.C.Tayal (HimalayPublication)*

Reference Books:

- ✓ *ElectronicdevicesandcircuitsR.L.Boylstad(PearsonIndia)*
- ✓ *ElectronicPrinciples- A.P.Malvino(TataMcGrawHill)*
- ✓ *PrinciplesofElectronics- V. K. MehtaandRohitMehta (S. ChandPub- lication)*
- ✓ *OP-Amps and Linear Integrated Circuit-R. A. Gayakwad (PrenticeHall)*
- ✓ *Physics of Semiconductor devices, DonaldANeamen(PrenticeHall)*
- ✓ AnalogSystemand Application: Gupta Kumar, PragatiPrakashan

LAB: Credit-1

(Minimum5experiments are tobe done)

1. To study the V-I characteristics ofa Zener diode and its use as voltage regulator.
2. Studyof V-Iandpowercurvesofsolarcells,andfindmaximumpowerpointandefficiency.
3. To study the characteristics ofa Bipolar Junction Transistor in CE configuration.
4. TostudythevariousbiasingconfigurationsofBJTfornormalclassAoperation.
5. Tostudythefrequencyresponseofvoltagegainofa RC-coupledtransistor amplifier.
6. TodesignaWienbridgeoscillatorforgivenfrequencyusinganon-amp.
7. To design a phaseshift oscillator ofgivenspecifications usingBJT.
8. To study the Colpitt's oscillator.

Reference Books:

- ✓ *ModernDigitalElectronics, R.P. Jain, 4thEdition, 2010, TataMcGrawHill.*
- ✓ *BasicElectronics:Atextlabmanual,P.B.Zbar,A.P.Malvino,M.A.Miller, 1994, McGrawHill.*
- ✓ *MicroprocessorArchitectureProgrammingandapplicationswith 8085, R.S.Goankar, 2002, PrenticeHall.*
- ✓ *Microprocessor8085: Architecture, Programmingandinterfacing,A.Wadhwa, 2010, PHILearning.*

Core IX

Basic Instrumentation

Course Outcomes

- Conceptualunderstandingofdifferentmeasurementofelectroniccircuitwithmeasuringdevices. CO-2: Basic understanding ofCRO and its applications.
- Basic understanding ofsignal generators and its analysis
- Basic understanding ofdigital instruments and their applications.
- To Apply theacquired knowledgeof differentelectronic measurement-basedinstruments inExperiments

Unit I

- **Basicof Measurement:**Instrumentsaccuracy,precision,sensitivity,resolutionrangeetc.Errorsinmeasurements and loadingeffects.
- **Multimeter:** Principles ofmeasurement ofdc voltageand dc current,acvoltage,accurrentandresistance.Specifications ofa multimeter and theirsignificance.
- **Electronic Voltmeter:** Advantage over conventional multi meter for voltage measurement withrespecttoinputimpedanceandsensitivity.Principlesof voltage,measurement(blockdiagramonly). Specifications ofan electronic Voltmeter/ Multimeter and their significance.
- **ACmillivoltmeter:**TypeofACmillivoltmeters:Amplifier-rectifier,andrectifier-amplifier.Blockdiagramac milli voltmeter,specifications and their significance.

Unit II

- **CathodeRayOscilloscope**:Blockdiagramof basic CRO. Construction ofCRT,Electrongun,electrostaticfocusing and acceleration (Explanation onlynomathematicaltreatment), brief discussiononscreenphosphor,visualpersistenceandchemical composition. Timebaseoperation,synchronization.Frontpanelcontrols. Specifications ofa CRO and their significance.
- **Applicationsof CRO:**(1)StudyofWaveForm,(2) Measurementof Voltage,Current,Frequencyand Phase Difference.
- Specialfeatures ofdual trace,introductiontodigitaloscilloscope,probes.DigitalstorageOscilloscope:Block diagram and principleofworking.

Unit III

Signal Generators andAnalysisInstruments: Block diagram, explanation and specifications oflowfrequencysignalgenerators,pulsegenerator,andfunctiongenerator,Brief ideafortesting,specifications,Distortion factor meter, waveanalysis.

Unit IV

- **Digital Instruments:** Principle and workingofdigitalmeters,Comparisonofanalogganddigitalinstruments, Characteristics ofa digital meter,Working principles ofdigital voltmeter.
- **Digital Multimeter:** Blockdiagramand workingof adigitalmultimeter, Working principleof timeinterval, frequency and periodmeasurementusinguniversalcounter/frequencycounter,time-basestability, accuracy and resolution.

LAB: Credit-1

The test oflab skills will be ofthe following testitems:

1. Useofanoscilloscope.
2. CROasaversatilemeasuringdevice.
3. Circuit tracing ofLaboratory electronic equipment.
4. Use ofDigital multimeter/VTVM for measuring voltages.
5. Circuit tracing ofLaboratory electronic equipment.
6. Winding a coil /transformer.
7. Study the layout ofreceiver circuit.
8. Trouble shootingacircuit.
9. Balancingofbridges.

LaboratoryExercises:

1. Toobservetheloadingeffectof amultimeterwhilemeasuringvoltage acrossalow resistanceandhighresistance.

2. To observe thelimitationsof a multimeterfor measuring highfrequency voltage and currents.
3. TomeasureQofacoilanditsdependenceonfrequency, usingaQ-meter.
4. Measurement ofvoltage, frequency, time period and phase angle using CRO.
5. Measurementoftime period,frequency,average period using universalcounter/frequency counter.
6. Measurement ofrise, fall and delay times using a CRO.
7. MeasurementofdistortionofaRFsignalgeneratorusingdistortionfactor meter.
8. Measurement ofR, L and C using a LCR bridge/universal bridge.

Open Ended Experiments:

1. UsingaDualTraceOscilloscope
2. Convertingtherangeof agivenmeasuringinstrument(voltmeter,ammeter)More emphasis should be given on hands-on experiments.

TextBooks:

- ✓ *ATextBooksbookofelectricaltechnology- B.L.Theraja (S.ChandPublishing)*
- ✓ *DigitalcircuitsandsystemsVenugopal (TataMcGrawHill)*

Reference Books :

- ✓ *DigitalElectronics-SubrataGhoshal (CengageLearning)*
- ✓ *ElectronicDevicesandcircuits - S. Salivahanan andN. S.Kumar (Tata Mc-GrawHill)*
- ✓ *ElectronicDevices-ThomasL. Floyd (Pearson)*

Additional Reference BooksforPractical papers :

1. AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop(AsiaPublishingHouse)
2. Practical Physics-B.B.Swain(KitabMahal)
3. Practical Physics-B.Ghosh (Vol. I andII)
4. ALaboratoryManualof 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 X

Nuclear and Particle Physics

Course Outcomes

- Understanding the properties of atoms in electric and magnetic field.
- Understanding the concept Nuclear physics.
- Conceptual understanding nuclear models and nuclear reactions.
- Conceptual understanding of particle physics.
- To Apply the acquired knowledge in conducting the experiments.

Unit I

Atoms in Electric and Magnetic Fields: Electron angular momentum. Space quantization, Electron Spin and Spin Angular Momentum, Larmor's Theorem, Spin Magnetic Moment, Stern Gerlach Experiment, Vector Atom Model, L-S and J-J coupling, Zeeman Effect, Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magnetron. Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect, Paschen back and Stark-Effect (qualitative Discussion only).

Unit II

Nuclear Physics- : Nuclear composition, charge, size, shape, mass and density of the nucleus; Nuclear angular momentum; Nuclear magnetic dipole moment; Electric quadrupole moment; Mass defect; Packing fraction and Binding energy; Stability of nuclei (N vs Z curve), Binding energy curve. semi empirical mass formula; Nuclear Forces: General concept of nuclear force; Yukawa Meson field theory of nuclear forces; Properties of Nuclear forces.

Radioactive disintegration; Properties of alpha, beta, gamma rays; law of radioactive decay; successive radioactive decay; radioactive equilibrium; Radioisotopes; application of radioactivity (Agriculture, Medicinal, Industrial and Archaeological).

Unit III

- **Nuclear models:** Liquid Drop model; Shell model; magic number in the nucleus; Alpha decay: Alpha particles spectra; Gamow's theory of Alpha decay; Beta decay: Shape of Beta ray spectrum; Explanation of Beta decay on the basis of Neutrino and Antineutrino hypothesis; Fermi theory of Beta decay; Selection rules; Gamma ray emission,

- **Nuclear reactions:** Kinds of Nuclear reactions; Nuclear reaction kinematics; Q-value; Compound Nucleus and concept of direct reactions; Conservation laws; Nuclear reaction cross- sections. Nuclear energy: Nuclear Fission; Chain reaction and Critical Mass; Nuclear Reactors and its basic components; Nuclear Fusion; Condition for the maintained Fusion reactions; Energy production in stars; Fusion reaction in Sun, Principle of atomic bomb and hydrogen bomb.

Unit IV

Particle Physics

Classification of particles-antiparticles and their interactions; Conservation laws; Charges; Isospin; Baryon number; Lepton number; Strangeness; Hyper charge; Parity; Charge conjugation; CPT theorem; Conservation laws; Quark as the building blocks of Hadrons; Quark Model; Colour degree of freedom, Symmetry Classification of elementary particles; Higgs Boson Particle (God particle), elementary idea on Large Hadron collider (LHC), The future of universe, Dark matter and dark energy.

Text Books

- ✓ *Concepts of Modern Physics Arthur Beiser (McGrawHill)*
- ✓ *Modern Physics Murugeshan and Sivaprasad(S.Chand)*
- ✓ *Cohen B. L., "Concepts of Nuclear Physics", McGraw Hill Education.*
- ✓ *Tayal D. C., "Nuclear Physics", Himalaya Publishing House.*
- ✓ *Patel S. B., "Nuclear Physics: An Introduction", New Age International Publishers.*
- ✓ *Singh Jahan, "Fundamental of Nuclear Physics", Pragati Publications*

Reference Books

- ✓ *QuantumMechanics:TheoryandApplications,A.K.GhatakandS.Lokanathan, (Macmillan)*
- ✓ *IntroductiontoQuantumTheory,DavidPark(DoverPublications)*
- ✓ *TheoryandProblemsofModernPhysics,Schaum'soutline,R.Gautreau and W.Savin- (Tata McGraw-Hill)*
- ✓ *ModernPhysics-Serway(CENGAGELearnings)*
- ✓ *PhysicsofAtomsandMoleculesBransdenandJoachim(PearsonIndia)*
- ✓ *AtomicandNuclearPhysics-A.B.Gupta(NewCentral)*
- ✓ *TheoreticalNuclearPhysics,J.M.BlattandV.F.Weisskopf(Springer)*

LAB: Credit-1

(Minimum4experiments are tobe done)

1. Study of photoelectric effect.
2. Basics of GM counter characteristics and counting statistics.
3. Study of Gamma ray spectroscopy by SCA and MCA.
4. TodeterminethePlanck'sconstantusingLEDsofatleast4 differentcolours.
5. Todetermine the value ofe/m by (a) Magnetic focusing or (b) Bar magnet.
6. To setup the Millikan oil drop apparatus and determine the charge ofan electron.

Reference Books:

1. AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop,1971,Asia Publishing House
2. Advanced level Physics Practicals,MichaelNelson andJonM.Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers
3. A Text Books BookofPractical Physics,I.PrakashandRamakrishna, 11thEdn,2011,KitabMahal

Core XI **Semester V**

DigitalSystems

Course Outcomes

- To Understand IC's and scales ofIntegration, Digital Circuitsandtheir realization,Applications
- Build strong knowledge about Boolean Algebra, Truth tables, EquivalentCircuits,Theoryand applicationofCRO.
- Gain a clear understanding ofData processing circuits, ArithmeticCircuits, different typesofTimers:IC555
- To Explain the knowledge ofcomputer organization,Shift registers and counters.
- To Apply the acquired knowledge to realize various types ofcircuits inexperiment

Unit 1

- **Integrated Circuits (Qualitative treatment only):** Activeand PassiveComponents,Discretecomponents,WaferChip,AdvantagesandDrawbacksof ICs,Scaleof Integration:SSI,MSI,LSIandVLSI(basicideaand definitions only), Classification ofICs, ExamplesofLinearand DigitalICs.
- **Digital Circuits:**DifferencebetweenAnalog andDigital Circuits, BinaryNumbers,DecimaltoBinaryandBinarytoDecimalConversation,BCD,OctalandHexadecimal numbers,AND,ORandNOT.Gates(realizationusingDiodesandTransistor),NANDandNORGates asUniversalGates,XOR and XNOR Gates and applicationas ParityCheckers.

Unit II

Booleanalgebra: DeMorgan'sTheorems:BooleanLaws,Simplificationof LogicCircuitusingBooleanAlgebra,FundamentalProducts,Ideaof MintermsandMaxterms,Conversionof truthtableintoKarnaugh MapandSOPandPOSsimplification. Universallogicimplementation(NAND&NOR).

Unit III

- **Data Processing Circuits:** Basic Idea ofMultiplexers, De-multiplexers, Decoders, Encoders.
- **Arithmetic Circuits:** Binary Addition. Binary Subtraction using 2s complement. Half and FullAdders. Halfand FullSubtractors, 4 bit binary Adder/Subtractor.
- **Timers:IC 555:**block diagram and application is Astablemultivibrator and Monostablemultivibrator.

Unit IV

- **IntroductiontoComputerOrganization:**Input/outputDevices,Datastorage(ideaof RAM andROM), Computer memory, Memory organization and addressing, Memory Interfacing,MemoryMap.

- **Shiftregisters:**Serial-in-serial-out,Serial-in-Parallel-out,Parallel-in-Serial-out and Parallel-in-Parallel-out. Shift Registers (only up to 4 bits)

- **Counters (4 bits):** Ring Counter, Asynchronous counters, Decade Counter.Synchronous Counter.

Text Books

- ✓ *Digital Circuits and Logicdesign:SamuelC.Lee(PrinticeHall)*
- ✓ *DigitalPrinciplesandApplications-A.P.Malvino, D.P.LeachandSaha (TataMcGraw*)

Reference Books:

- ✓ *TheArtofElectronicsbyPaulHorowitzandWilfieldHill ,Cambridge University*
- ✓ *ElectronicsbyAllan R. Hambley,PrenticeHall 3.PrinciplesofElectronics V.K.MehtaandRohitMehta(S.ChandPublishing)*
- ✓ *DigitalLogicandComputerdesignM.MorrisMano(Pearson)5.ConceptsofElectronicsD.C.Tayal(Himala yaPublishinghouse)*
- ✓ *DigitalSystemand Application, Gupta Kumar, PragatiPrakashan*

LAB: Credit-1

(Minimum6experiments are tobe done)

1. To measure (a) Voltage, and (b) Time period ofa periodic waveform usingCRO
2. and to test a Diode and Transistor usingaMillimeter.
3. Todesign a switch (NOT gate) using a transistor.
4. ToverifyanddesignAND, OR, NOTandXORgatesusingNANDgates.
5. HalfAdder, FullAdder and 4-bit binary Adder.
6. Half Subtractor, Full Subtractor, Adder-Subtractor using Full AdderI.C.
7. TobuildFlip-Flop (RS, Clocked-RS, D-type and JK) circuits usingNANDgates.
8. Todesignanastablemultivibratorofgivenspecificationsusing 555Timer.
9. Todesignamonostablemultivibratorofgivenspecificationsusing 555 Timer.

Reference Books:

- ✓ *BasicElectronics: ATextBookslabmanual,P.B. Zbar,A.P.Malvino,M.A. Miller,1994, Mc-GrawHill.*
- ✓ *OP-AmpsandLinearIntegratedCircuit,R.A.Gayakwad,4thedition,2000,Prentice Hall.*
- ✓ *Electronic Principle, Albert Malvino, 2008,Tata Mc-GrawHill.ElectronicDevices and circuit Theory, R.L.Boylestad and L.D.Nashelsky,2009, Pearson.*

Core XII

Quantum Mechanics and Applications

Course Outcomes

- To understandPropertiesand physicalinterpretationofwavefunctionanditsapplication, knowledgein probabilitycurrentdensity,significanceof momentumspacetransformationandtimedependentSchrödingerequation.
- To explain Time independentSchrödinger equation,Eigenvalue,Eigenfunction,generalizedsolutionof stationary states, knowledge in wave function and discreteenergylevel.
- Basic knowledge in quantum mechanical operators, Eigen valueandEigenfunction,Uncertaintyrelationand Gaussian wave packet.
- Acquiretheknowledgeinapplicationof Schrödingerequationindifferent potential barriers,conceptof simple harmonic oscillator.
- Apply the acquired knowledge to solve various numerical problems.

Unit I

Schrodinger equation: Time dependent Schrodingerequation,PropertiesofWaveFunction,Physical interpretationof wavefunction,Wavefunctionof afree particle,Normalization,Probabilitycurrentand probabilitycurrentdensitiesinthreedimensions, LinearityandSuperpositionPrinciple, WavePacket,FourierTransformTheorem, Momentumspacewavefunctionanditssignificance, Representationof positionvectorinmomentumspace. Schrodingerequationinmomentumspace.

Unit II

TimeIndependentSchrodingerequationin 1-D,2-Dand3-D,Hamiltonian,stationarystatesandenergy Eigenvalues,expansionof anarbitrarywavefunctionasalinearcombinationof energyEigenfunctions,Generalsolutionof thetimedependentSchrodingerequationintermsof linearcombinationsof stationarystates. General DiscussionofBoundstates inanarbitrary potential:Continuityofwavefunction, Boundarycondition and emergenceofdiscreteenergy levels.

Unit III

Operators: Operators, Commutator Algebra, Position, Momentum, Angular Momentum and Energy operators, Hermitian Operators, ExpectationValue,Expectation valuesof positionand momentum, Ehrenfest Theorem, Eigenvalues and Eigenfunctionsof Hermitian Operator,EnergyEigenSpectrum,Degeneracy,Orthonormalityof Eigenfunctions,Linear Dependance, Orthogonalisation, UncertaintyRelation- Uncertainty product, minimum uncertainty wave packet-Gaussian Wave Packet.

Unit IV

Applicationtoonedimensionalproblem-Onedimensionalinfinitelyrigid Box-EnergyEigenvaluesandEigenfunctions, normalization,quantumdotasanexample,Quantummechanicalscatteringandtunnelinginonedimensionacrossa PotentialStepandRectangularPotentialBarrier,FiniteSquarewellpotential,Quantummechanicsofsimple Harmonic Oscillator-EnergyLevelsandEnergyEigenfunctions,ground state, zeropointenergy.

TextBooks:

- ✓ *Introduction to Quantum Theory David Park (DoverPublications)*
- ✓ *Introduction to Quantum Theory,D. J. Griffiths(Pearson)*
- ✓ *Quantum Mechanics: Concepts and applications, N.Zettili, Wiley*

Reference Books :

- ✓ *Quantum Mechanics, TheoryandapplicationsA.Ghatakand S.Lokanathan(McMillanIndia)*
- ✓ *QuantumMechanics- G.Aruldhas (PrinticeHallofIndia)*
- ✓ *QuantumPhysics–S. Gasiorowicz (Wiley)*
- ✓ *QuantumMechanics- G.R.ChatwalandS.K.Anand*
- ✓ *Quantum Mechanics -J.L. Powell and B. Craseman(Narosa)*
- ✓ *Introductionto QuantumMechanicsM.Das andP.K.Jena (ShriKrishnaPublication).*

LAB: Credit-1

UseC/C++/Scilabforsolvingthefollowingproblemsbasedon Quantummechanicslike(Usefinitedifferencemethod,matrix method, ODE Solvermethod in all cases)

1. Solvethe s-wave Schrodinger equation forthe ground state and the first excited state ofthe Hydrogen atom:

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

Where, 'm' is the reduced massof the electron.Obtaintheenergyeigenvaluesand plot thecorrespondingwavefunctions.Rememberthatthegroundstateenergyofthehydrogenatomis~-13.6ev. Take e= 3.795 $\sqrt{(eV\text{Å})}$, ħc=1973(eVÅ)and m=0.511× 10^6 eV/c^2.

2. Solve theS-Wave radialSchrodinger equation for anatom:

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

Where, 'm' is the reduced massofthesystem(Whichcan bechosentobethemassof anelectron),for thescreenedcoulombpotential: $v(r) = -\frac{e^2}{r}e^{-r/a}$

Findtheenergy(ineV)of thegroundstateof theatomtoanaccuracyof thesignificantdigits.Also;plotthecorrespondingwavefunction.Takee=3.795 (evÅ),ħc=

1973(eVÅ)andm=0.511 × 10^6eV/c^2, and α =3Å, 5Å, 7Å. Thegroundstateenergyisexpectedto beabove-12eVinallthreecases.

3. Solve theS-Wave radialSchrodinger equation for a particle ofmassm:

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

For the anharmonic Oscillator potential:$V(r) = \frac{kr^2}{2} + \frac{br^3}{3}$.

Findthegroundstateenergy (inMeV)oftheparticletoanaccuracyofthree significantdigits. Also, plotthecorrespondingwavefunction.Choosem=940MeV/C^2,k= 100MeV/fm^2,b= (0, 10, 30)MeV/fm^3.Intheseunits,c=197.3MeVfm. [The groundstateenergyisexpectedtoliebetween90and110MeVforallthreecases].

4. Solve theS-Wave radialSchrodinger equation for the vibrationsofhydrogenmolecule:

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

Where,'m'isthe reducedmasofthetwo-atomsystemfortheMorsepotential

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

Where r = r-r_0.

Find the lowest vibrational energy (in MeV) ofthe molecule toanaccuracyofthreesignificantdigits. Also plot the corresponding wave functions for the choices given below:

m=940x10^6ev/c^2, D=0.755501ev, α=1.44, r_0 =0.131349Å

m=940x106ev/c^2, D=0.755501ev, α=1.44, r_0 =0.131349Å

Laboratory based experiments:

1.StudyofElectronspinresonance- determinemagneticfieldasafunctionofthe resonance frequency.

2.Study ofZeeman effect: with external magneticfield; Hyperfinesplitting

3.To show the tunneling effect in tunnel diode using I-V characteristics.

4.Quantum efficiency ofCCDs

Reference Books:

- ✓ *Schaum'soutlineofProgrammingwithC++.J.Hubbard,2000,McGraw–Hill Publication*
- ✓ *NumericalRecipesinC: TheArtofScientificComputing, W.H. Pressetal.,3rdEdn.,2007, CambridgeUniversityPress.*
- ✓ *Anintroduction to computational Physics, T.Pang, 2nd Edn.,2006,Cam- bridge Univ. Press*
- ✓ *Simulation ofODE/PDE Models with MATLAB, OCTAVE andSCILAB:Scientific andEngineeringApplications: A. VandeWouwer, P.Saucez,C.V. Fernndez.2014 Springer.*
- ✓ *Scilab (AFreeSoftwaretoMatlab):H.Ramchandran,A.S. Nair. 2011S.Chand andCo.*
- ✓ *ScilabImageProcessing: L.M.Surhone.2010 BetascriptPublishingISBN:9786133459274*

Core XIII

SolidStatePhysics

Course Outcomes

- TounderstandtheConceptofcrystalstructureandproperties,X-rayDiffraction,Bragg'sand
- Laue'scondition.
- ConceptualunderstandingofLatticevibration,EinsteinandDebyespecificheattheoriesofsolids, knowledgeinBandtheory, Kroning-PennymodelandHallEffect.
- UnderstandingtheConceptinmagneticanddielectricpropertiesofmaterials.
- BasicknowledgeonLASERanditsgeneration, types. Conceptualunderstandingofsuperconductivityanditstype, London'sEquation, PenetrationDepthandBCStheory.
- ToApplytheacquiredknowledgeinexperiments.

Unit I

CrystalStructure: Solids,AmorphousandCrystallineMaterials,LatticetranslationVectors,Latticewitha Basis. Central and Non-Central Elements. Unit Cell,MillerIndices,TypesofLattices,ReciprocalLattice,Brillouin zones, DiffractionofX- rays by crystals, Bragg'sLaw,Laue'sCondition,AtomicandGeometrical Factor.

Unit II

- **Elementary Lattice Dynamics:** Lattice VibrationsandPhonons:Linear,MonoatomicandDiatomicChains, AcousticalandOpticalPhonons,Qualitative Descriptionofthe phononspectruminsolids, DulongandPetitsLaw, EinsteinandDebyetheoriesofspecificheatofsolids, r^3 Law.
- **Elementarybandtheory:**Kroning-Pennymodelof bandGap,Conductor,Semiconductor(PandNtype)andinsulator,ConductivityofSemiconductor,mobility,HallEffect,Measurementofconductivity (four probe method) and Hall Co- efficient.

Unit III

- **Magnetic Properties of Matter:**Dia-,Para-,Ferri-andFerro-magneticMaterials,ClassicalLangevinstheoryof diaandParamagneticDomains,Curieslaw,WeissTheoryof Ferromagnetismand Ferromagnetic Domains, Discussion ofB- H Curve, Hysteresis and Energy Loss.
- **DielectricPropertiesof Materials:** PolarizationLocalElectricalFieldatan Atom, DepolarizationField, Electric Susceptibility, Polarizability, ClausiusMosotti Equation,ClassicaltheoryofElectronicPolarizability.

Unit IV

- **Lasers:** EinsteinsAandBco-efficientnts, MetastableStates,SpontaneousandStimulatedemissions,OpticalPumpingandpopulationInversion,Three LevelandFourLevelLasers,RubyLaserandHe-Ne Laser.
- **Superconductivity:** ExperimentalResults, CriticalTemperature, Critical magnetic field, Meissnereffect, Type-Iand Type-IISuperconductors, London's EquationandPenetrationDepth,Isotopeeffect,Idea ofBCS theory (No derivation).

Text Books:

- ✓ *Introduction to Solid State Physics- Charles Kittel (WileyIndia)*
- ✓ *LASERS: Fundamentals and Applications- Thyagarajan and Ghatak(McMillan India)*

Reference Books:

- ✓ *SolidStatePhysics-N.W.AshcroftandN.D.Mermin (Cengage)*
- ✓ *Solid State Physics- R.K.Puri and V.K. Babbar (S.Chand Publication)*
- ✓ *Solid State Physics S. O. Pillai (New Age Publication)*
- ✓ *Lasers andNon-linear Optics B.B.Laud (Wile yEastern)*
- ✓ *Elements ofSolid State Physics-J.P. Srivastava (Prentice Hall ofIndia)*
- ✓ *Elementary Solid State Physic s-Ali Omar (Addison Wiley)*
- ✓ *SolidStatePhysics, GuptaandKumar,PragatiPrakashan.*

LAB: Credit-1

(Minimum 4 experiments aretobedone)

1.Measurement ofsusceptibility ofparamagnetic solution (Quinck's Tube- Method)

2.TomeasuretheMagneticsusceptibilityofSolids.

3.Tomeasure the Dielectric Constant ofa dielectric Materials with frequency

4.TodeterminetheHallcoefficientofasemiconductorsample.

5. TodrawtheBHcurveof Feusingsolenoidandtodeterminetheenergylossfrom Hysteresis

6.Tomeasurethebandgapofagivensemiconductorbyfour-probemethod.

Reference Books:

1.AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop, 1971,Asia Publishing House.

2.AdvancedlevelPhysicsPracticals,MichaelNelsonandJonM.Ogborn,4thEdition, reprinted1985, Heinemann Educational Publishers.

3.ATextBooksBookof PracticalPhysics,I.PrakashandRamakrishna, 11 Ed.,2011, KitabMahal

4.Elements ofSolid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice- Hall ofIndia.

Core XIV **Semester VI**

ElectromagneticTheory

Course Outcomes

- Physical significance ofMaxwellEquationanditsapplicationtofree space,LorentzandCoulomb gauge transformation, poynting theorem, concept ofenergy density.
- Analysisof Maxwell'sequationsindifferentmediaandPhysicalsignificanceof relaxationtime, skin depth, Electrical conductivity ofionized gases, plasmafrequency.
- Basic understanding ofpolarization of EM wave, and different types of crystals, Phase
- Retardation Plates and Rotatory Polarization.
- Conceptualunderstandingof EMWapplicationinboundedmedia,planeinterface,dielectricmedia, Brewster's law, TIR, Evanescent wave, metallic reflection.
- To Applythe acquiredknowledge forvisualizebasicconceptofphenomenonoflightinvarious experiments

Unit I

MaxwellEquations: Maxwellsequations,DisplacementCurrent,Vector andScalarPotentials,Gauge Transformations: Lorentz and Coulomb Gauge, Wave Equations, Plane Waves in free space andcharacteristics, Poynting TheoremandPoyntingVector,Electromagnetic (EM) EnergyDensity,Physical Concept ofElectromagnetic Field Energy Density.

Unit II

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum andisotropicdielectricmedium,transversenatureof planeEMwaves, refractive index anddielectricconstant,waveimpedance,Propagation through conducting media, relaxation time, skin depth,Electricalconductivityof ionizedgases, plasmafrequency, refractiveindex,skindepth,applicationtopropagation through ionosphere.

Unit III

- **Polarizationof Electromagnetic Waves:** Description of Linear,Circularand EllipticalPolarization,uniaxial and biaxial crystals, light propagation in uniaxial crystal, double refraction,polarizationbydoublerefraction,NicolPrism,Ordinaryandextraordinaryrefractiveindices ,Production and detection ofPlane, Circularly and Elliptically polarized light,
- **PhaseRetardationPlates:**Quarter-WaveandHalf-WavePlates.BabinetsCompensatorandits Uses, Analysis ofPolarized Light.

- **RotatoryPolarization:**OpticalRotation,BiotsLawsforRotatoryPolarization,FresnelsTheoryofoptical rotation, Calculation of angle of rotation,Experimental verificationof Fresnelstheory,Specific rotation, Laurents half- shade polarimeter.

UnitIV

EM Wave inBoundedMedia: Boundaryconditionsat a plane interface between two media,Reflection and Refraction of plane waves at plane interface between two dielectric media, Laws of Reflection and Refraction, Fresnel's Formulae for perpendicular and parallel polarization cases,Brewster'slaw,ReflectionandTransmissioncoefficients,Totalinternalreflection,evanescentwaves,Metallic reflection (normal Incidence)

Text Books:

- ✓ *Introduction to Electrodynamics, D.J. Griffiths (Pearson)*
- ✓ *PrinciplesofOptics-MaxBornandE. Wolf.*

Reference Books :

1. Classical ElectrodynamicsbyJ.D.Jackson.
2. Foundation ofelectromagnetic theory: Ritz and Milford(Pearson).
3. Electricity and Magnetism: D C Tayal (Himalaya Publication)
4. Optics: A.K.Ghatak
5. Electricity andMagnetism :Chattopadhyaya, Rakhit (NewCentral)
6. Electromagnetic Theory, Gupta and Kumar, PragatiPrakashan

LAB: Credit-1

(Minimum 4 experiments are to be done)

1. ToverifythelawofMalusforplanepolarizedlight.
2. Todetermine the specific rotation ofsugar solution using Polarimeter.
3. Toanalyze elliptically polarized Light byusing a Babinets compensator.
4. Todeterminetherefractiveindexofliquidbytotalinternalreflectionusing Wollastonsair-film.
5. TodeterminetherefractiveIndexof (1) glassand (2)aliquidbytotalinternal reflection using aGaussianeyepiece.
6. To study the polarizationof light by reflectionanddeterminethepolarizinganglefor air-glassinterface.
7. To verify theStefan's law ofradiation and to determineStefan'sconstant.
8. TodeterminetheBoltzmannconstantusingV-Icharacteristicsof PNjunction Diode.

Reference Books:

- ✓ *AdvancedPracticalPhysicsforstudents,B.L.FlintandH.T.Worsnop, 1971,Asia Publishing House.*
- ✓ *AdvancedlevelPhysicsPracticals,MichaelNelson and JonM. Ogborn, 4ThEdition, reprinted1985, Heinemann Educational Publishers*
- ✓ *ATextBooksBookofPracticalPhysics,I.PrakashandRamakrishna, 11Ed.,2011,KitabMahalElectromagneticFieldTheoryforEngineersandPhysicists,G.Lehner,2010,Springer*

Core XV

Statistical Mechanics

Course Outcomes

- Understandingtheconceptof ensemblesanditspartitionfunction,phase spaceand thermodynamic relations, MBdistribution law.
- Conceptual understanding of additionof entropy,SackurTetrodeequation,Lawofequipartition ofEnergyand itsapplication.
- Basicpostulatesanddifferentdistributionof Fermi andDiracparticlesandB-Econdensation.
- Basic knowledge in thermal and Black body radiation, Concept of different laws ofradiation and theirexperimental verification.
- Applytheacquiredknowledgeforanalyzethelawsradiationanddifferentdistributionfunctions usingcomputational analysis.

Unit I

ClassicalStatistics-I: MacrostateandMicrostate,ElementaryConceptofEnsemble,Microcanonical,CanonicalandGrandCanonicalensemble, Phase Space,Entropy and ThermodynamicProbability,Maxwell-Boltzmann Distribution Law, Partition Function.

Unit II

ClassicalStatistics-II: ThermodynamicFunctionsofanIdeal Gas,classicalEntropy Expression,GibbsParadox,SackurTetrodeequation,Lawof equipartitionof Energy(withproof)-Applicationsto SpecificHeat and its Limitations, Thermodynamic Functionsofa twoenergylevelssystem, NegativeTemperature.

Unit III

QuantumStatistics: Identicalparticles,macrostatesandmicrostates,FermionsandBosons,Bose EinsteindistributionfunctionandFermi-Diracdistributionfunction.Bose-EinsteinCondensation,Bose deviation from Planck's law,Effectof temperatureon Fermi-Diracdistributionfunction,degenerate Fermi gas, Density of States Fermi energy.

Unit IV

- **Radiation:**Propertiesof Thermal Radiation,BlackbodyRadiation,PureTemperaturedependence,Kirchhoff'slaw,StefanBoltzmannlaw:Thermodynamicproof,RadiationPressure,Wein'sDisplacementlaw, Wien's distribution Law,Saha's Ionization Formula, RayleighJeansLaw, UltraVioletcatastrophe.
- **Planck's Law ofBlack body Radiation:** Experimental verification, Deduction of

  Wien's Distribution Law, (2) Rayleigh Jean's Law, (3)Stefan BoltzmannLaw, (4) Wein'sDisplacement Law from Planck's Law.

Text Books*:*

- ✓ *Introduction to Statistical Physics by Kerson Huang(Wiley).*
- ✓ *StatisticalPhysics, BerkeleyPhysicsCourse,F.Reif (TataMcGraw-Hill)*

Reference Books:

- ✓ *StatisticalMechanics, B.K. AgarwalandMelvinEisner (NewAgeInter-national)*
- ✓ *Thermodynamics,KineticTheoryandStatisticalThermodynamics:FrancisW.Sears andGerhardL.Salinger (Narosa)*
- ✓ *Statistical Mechanics: R.K. Pathria and Paul D. Beale (AcademicPress)*
- ✓ *Statistical Mechanics: Sharma andSatyal,KalyaniPublishing*
- ✓ *BasicStatistical Mechanics, Gupta and Kumar, PragatiPrakashan*

LAB: Credit-1

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation andcompare it withWein's.
2. LawandRaleigh-JeansLawathightemperature(roomtemperature)andlow
3. temperature.
4. Plot SpecificHeatofSolidsbycomparing(a)Dulong-Petitlaw,(b)Einsteindistributionfunction,(c)Debye distributionfunctionfor high temperature (roomtemperature) and low temperature and compare them for thesetwocases
5. Plot Maxwell-Boltzmann distribution function versus temperature.
6. Plot Fermi-Dirac distribution function versus temperature.
7. Plot Bose-Einstein distribution function versus temperature.

Reference Books:

- ✓ *ElementaryNumericalAnalysis,K.E.Atkinson,3rdEdn.2007,WileyIndiaEdition*
- ✓ *StatisticalMechanics, R.K. Pathria, ButterworthHeinemann: 2ndEd.,1996,Oxford UniversityPress.*
- ✓ *Thermodynamic,KineticTheoryandStatisticalThermodynamics, Fran-cisW.SearsandGerhardL.Salinger,1986, Narosa.*
- ✓ *ModernThermodynamicswithStatisticalMechanics,CarlS.Helrich,2009,Springer*
- ✓ *Simulationof ODE/PDEModels withMATLAB,OCTAVEandSCILAB:Scientific andEngineeringApplications:A.VandeWouwer,P. Saucez, C.V.Fernndez.2014 SpringerISBN: 978-3319067896*
- ✓ *Scilabbyexample: M. Affouf, 2012. ISBN: 978-1479203444*
- ✓ *ScilabImageProcessing: L.M.Surhone. 2010,BetascriptPub.,ISBN:978613345927*

Core XVI **Semester VII**

Mathematical Methods in Physics

Course Outcomes (Cos)

- Understanding of Complex Variables and Contour Integration: Gain a comprehensive understanding of complex variables and contour integration techniques, including their applications in mathematical analysis and physics.
- Learning Tensors for Physics: Acquire knowledge and proficiency in working with tensors, a fundamental mathematical tool in physics used to describe physical quantities and their transformations.
- Understanding Group Theory: Develop a deep understanding of group theory and its role in physics, including applications in symmetry analysis and quantum mechanics.
- Learning Special Functions for Applications in Physical Problems: Master specialized functions commonly used in physics to solve complex problems, enhancing problem-solving skills and expanding mathematical techniques.

Unit-1

Complex Variables: Analytic functions, Contour integrals, Cauchy's integral theorem, Laurent's series,singular points, residues and the Residue Theorem, Evaluation of real definite and indefinite integrals by contour integration, indented semi-circular contour, evaluation of single and multi- valued functions, branch points and branch cuts, Contour integration involving branch point.

Unit -2 Tensors:

Introduction, Types of tensor, Invariant tensor, epsilon tensor, Pseudo tensor, the algebra of tensor, Quotient law, Metric Tensor, Covariant derivative of tensor, Fundamental Tensor, Cartesian tensor, Christoffel symbol.

Unit -3

Group Theory: Definitions of groups, subgroups and classes, Isomorphism, Homomorphism, Cayley's theorem, Group representations, Orthogonality theorem, characters, Orthogonality relation for group character, Character table, Preliminary idea about infinite group, calculation of generator, Calculation of generator associated with S.U. (2) and SO(3) group,

Unit -4

Special Functions: Legendre Polynomials, generating functions, Recurrence formulae, Orthogonality properties of Legendre's polynomial of 1st kind, Bessel generating function, Bessel function of 1_{st} and 2_{nd} Kind, Recurrence formulae, Orthogonality properties of Bessel's polynomials, Spherical Bessel functions, Fourier and Laplace transformation.

Text books:

- ✓ *Mathematical Methods of Physics by Mathews and Walker (W. A. Benjamin Inc.)*
- ✓ *Matrices and Tensors in physics by A. W. Joshi (New Age International Publisher)*
- ✓ *Mathematical Methods in the physical Science by Mary L. Boas (Wiley- India)*

Reference Books:

- ✓ *Mathematical Methods for Physicist by G. Arfken and H. Weber, Academic Press (Elsevier)*
- ✓ *Elements of Group Theory by A. W. Joshi (New Age International Publisher)*
- ✓ *Mathematical Physics by H. K.Das and Dr. R. Verma (S. Chand & Company L.T.D.)*
- ✓ *Mathematical Physics by P. K. Chattopadhyaya (New Age International)*

Core XVII

Classical Mechanics

Unit-1

KINEMATICS OF RIGID BODY MOTION

Independent coordinates of a rigid body, Orthogonal transformations,Eulerianangles,infinitesimal rotations, rateofchangeofvector,Coriolisforce,angularmomentumandkineticenergyofmotionabout apoint,inertialtensorandthemomentof inertia,Eigenvaluesof Inertialtensorandtheprincipalaxis transformation,methodsofsolvingrigidbodyproblemsandEuler'sequationsofmotion,torque free motion ofa rigid body. Heavy symmetrical top with one point fixed.

Unit-2

HAMILTONIAN FORMULATION: Calculus of Variations andEuler-Lagrange'sEquation,BrachistochroneProblem,Hamilton'sPrinciple,Extensionof Hamilton's Principle to Nonholonomic Systems,LegendreTransformationandtheHamiltonEquationsof Motion,Physical Significanceof

Hamiltonian,DerivationofHamilton'sEquationsofMotionfrom aVariationalPrinciple,Routh's Procedure, PrincipleofLeastAction

Unit-3

CANONICAL TRANSFORMATIONS:

Canonical Transformation, Types ofGenerating Function,conditions for canonical transformation, Integral Invariance ofPoincare, Poisson Bracket, Poisson'sTheorem, Lagrange Bracket, Poisson and Lagrange Brackets as CanonicalInvariant,Infinitesimal CanonicaltransformationandConservationTheorems,Liouville'sTheoremHamiltonJacobiTheory:Hamilton-JacobiEquationforHamilton'sPrincipalFunction,HarmonicOscillatorandKeplerproblembyHamilton-JacobiMethod,Action-AngleVariablesforcompletelySeparableSystem,KeplerProbleminAction-AngleVariables

Unit-4

SMALL OSCILLATION: Problem of Small Oscillations, Example oflinear triatomic molecule and two coupled Oscillator, General Theory of Small Oscillations, Normal Coordinates and Normal ModesofVibration.

Test Books:

- ✓ *Classical Mechanics- by H. Goldstein (Addison-Wesley)*

Reference books:

- ✓ *Classical Mechanics byS. N. Biswas, Books and Allied Publisher Ltd.*
- ✓ *Classical Mechanics by J.C. Upadhay, Himalaya Publishing House.*
- ✓ *Classical Mechanics by Landau and Liftshitz (Butter Worth)*

Core XVIIIQUANTUM MECHANICS

Unit I

- **GENERAL PRINCIPLES OF QUANTUM MECHANICS:**

  A-Postulates ofQuantumMechanics and meaning ofmeasurement, Operators and their expectation values,Schrodingerequation, Particleina box,Orthogonalityof eigenfunctions.Dirac Notations, Linear vector space, Ket and Bra vectors, , Dirac delta function,linearoperators,Adjoint operators, Unitary Operators, Hermitianoperators,Eigenvaluesandeigenvectors, orthonormalityofeigenvectors, probabilityinterpretation, Degeneracy,.

- **B-QUANTUM DYNAMICS:**

  Time evolution of quantum states,Timeevolutionoperatoranditsproperties,Schrödinger, HeisenbergandInteractionpicture,Equationsof motion,Operatormethodsolutionof Harmonic oscillator problem, Matrix representation and time evolution ofcreation and annihilationoperators.

Unit II

- **ROTATION AND ORBITAL ANGULAR MOMENTUM:**

  A-Orbitalangularmomentumoperatorsasgeneratorsofrotation,Lx,Ly,LzandL^2 andtheirCommutation relations, Raising and Lowering operators (L+andL-),Lx,Ly,LzandL^2 insphericalPolarcoordinates,EigenvaluesandEigenfunctionsofLzandL^2(operatormethod), MatrixrepresentationofLx, Ly, LzandL^2.

- **B-SPIN ANGULAR MOMENTUM:**

  Spin½ particles,Paulispinmatricesandtheir properties,EigenvaluesandEigenfunctions,Spin androtations.Totalangularmomentum:TotalangularmomentumJ,Eigenvalueproblemof Jz andJ^2,Angularmomentummatrices,Additionof angularmomentumandC.G.coefficientsforthe states with (i)j_1 =½ andj_2 =½ (ii)j_1 =1 andj_2 =½.

Unit-III

A-Motion in a spherically symmetric field: The hydrogen atom,**Approximatemethods:**Stationary perturbation theory,RayleighSchrodinger methodfor non-degeneratecase,first and secondorder perturbation,**Variationalmethod**: GroundState, H -atom One-Dimensional Harmonic Oscillator,**W. K. B. method**: Connection formulas, Bohr-Sommerfeld quantization rule,**Time-dependent perturbation theory:**Transition probability, constant and harmonic perturbation, Fermi Golden rule.

Unit IV

Scattering amplitude and scattering cross section:

Born approximation, application to Coulomb and screened Coulomb, potentials. Partial waveanalysis for scattering, optical theorem, scattering from a hardsphere,resonantscatteringfroma square wellpotential.Elementaryidiaon identical particles.

Text books:

- ✓ *" QuantumMechanics:ConceptsandApplications"byNouredineZettileJohnWileyandsons.*

Reference Books:

- ✓ "*QuantumMechanics",L.I.SchiffL.I 3rdEd, McGrawHillBookCo.*
- ✓ *"QuantumMechanics"E.Merzbacher,2ndEd.,JohnWiley&Sons.*
- ✓ *"QuantumPhysics",S.GasiorowiczJohnWiley.*
- ✓ *"A Text Book ofQuantum Mechanics" byP.M.Mathews .andVenkatesan , TataMcGraw Hill.*
- ✓ *IntroductiontoQuantumMechanics,byD.J.Griffiths,2ndedition ,PearsonPublications*

Core XIX

LABORATORY: COMPUTATIONAL PHYSICS: 4 CREDITS

1. Introduction to theprogramming language (e.g. C /C++/ Fortran/ Matlab/Scilab) . The introduction isaccompaniedbyexamplesinthefollowinggeneralareas.

   (a)SortingAlgorithms--selectionsort,Quicksortetc.

   (b) Solution of equation -- Newton'smethod,Secantmethodetc.

   (c)Simplenumericalintegratons--Trapezoidal rule, simpson1/3 rule.

2. Classical mechanics (2nd order ODE, initial value problems).Euler mthod, Modified-Euler(predictor-corrector)method,Runge-Kuttamethod,Leapfrogmethod,Verletmethod,VelocityVerletmethod,eachwithandwithoutvelocitydependentdragterms,harmonicoscillatorwithdamping,forced one, realistic projectile motion with air drag,realistic planetary orbit calculation.

3. QuantumMechanics(2ndorderODE,boundaryvalueandeigenvalueproblems).Shootingmethodand Numerov's method, examplesof boundstatescalculationfor1D wells ,quantum harmonic oscillators. Eigenvalue probleminmatrixform(finitedimensionalbasis),andexact(Lanczos)diagonalization, Variationalcalculationwith orthogonal basis states. Time-dependentSchrodinger equation, wave equation.

4. Statistical Mechanics (Stochastic and Monte Carlo Methods). Uniform randomnumber generation, Randon walk and diffusion, Monte CarloIntegration--advantageinhigherdimension,error analysis.Importancesamplinganddetailedbalance.Generationof random numbers fromaGaussiandistribution--BoxMillermethod,usingcentrallimittheorem,Samplingpointsfromarbitrarydistributions--Metropolis sampling andexamples.

References:

- ✓ *Computational Physics, N. J. Giordano and H. Nakanishi, Pearson PrenticeHall(2006)*
- ✓ *Introduction to Computational Physics, Pao Tang, Cambridge University Press*
- ✓ *Computational Physics,S. E. Koonin and D. C. Meredith, Addison-WesleyPublishing Company*
- ✓ *Computational Physics, J. M. Thijssen, Cambridge University Press*

Core XX **Semester VIII**

ClassicalElectrodynamics

Unit –I

- **Covariant formulation of electrodynamics:**

  Lorentz transformation;Scalars, vectors and Tensors; Maxwells equations and equationsofcontinuity in terms ofAμ and Jμ; Electromagnetic field tensor anditsdual;CovariantformofMaxwell‟s equations; Lagrangian for a charged particle in presenceofexternalelectromagnetic field and Maxwell's equation as Euler-Lagrangeequations.

- **The Inhomogeneous Wave equation:**
  Wave equations for potentials, solution byFourier analysis, Radiation field,Radiationenergy, Hertzpotential, ComputationofradiationfieldsbyHertzmethod, electricdipoleradiation,multipole-radiation.

Unit –II

- **Lienard-Wiechart potential and Field of auniformlymovingelectron:**Lienard-Wiechart potential,Fieldsof achargein uniform motion,Direct solutionof the wave equation,Convectionpotential, Virtual photon concept.
- Wave guides, Propagation ofelectromagnetic waves in rectangular wave guides**.**

Unit–IIIRadiation from Accelerated Charges

Radiationfromanacceleratedcharge,Fieldsof anacceleratedcharge radiationatlow velocity, Caseofvelocityparalleltoacceleration, radiationfromcirculararbits,Radiationwithnorestrictions on the acceleration or velocity, Classicalcrosssectionfor bremsstrahlunginaCoulomb field, Cherenkov radiation.

Unit–IVRadiation, scattering and dispersion

Radiative damping of a chargedharmonic oscillator,forced vibrations, scattering by an individualfreeelectron,scatteringbya boundelectron,absorptionof radiation byanoscillator, equilibriumbetweenanoscillatorandaradiationfield, effectofavolumedistributionofscatters, scattering from a volume distribution, Rayleigh scattering, thedispersion relation.

Text Book:

- ✓ "*ClassicalElectricityandMagnetism"byWolfgangK.H.PanofskyandMelbaPhilips,SecondEdition.*

Reference books:

- ✓ "*Classical Electrodynamics", Jakson J D, John Wiley.*
- ✓ *'IntroductiontoElectrodynamics", GriffithsDJ,PrenticeHall*

Laboratory:Optics and Modern Physics Lab (4 credit)

M.B: Following is the list ofsome experiments however, the collegecanaddanyotherexperiments aspertheconvince.

Optics &Modern Physics:

1.Determination ofBoltzmann constant using V-I characteristics ofPNdiode.

2.Determination ofPlanck's constant using LEDs atleastfourcolors.

3.Determinationofe/mbyBarmagnet/magneticfocussung

4. Studyofphoto-electriceffect.

5. Studyofdiffractionpatternofsingleanddoubleslitsusinglasersourceanddeterminationof itswavelength.

6. Studytheelectricalresistanceasafunctionoftemperature. ExperimentswithMichelsoninterferometer: Determination ofA and αThicknessofmicasheet

7.FabryPerotinterferometerPolarizationExperimentsBabinetcompensatorEdsar-ButlerbandsQuarter wave plate Mallus LawStudy ofelliptical polarized light

8. Constant DeviationSpectrography Calibration Zeeman effect

9.Babinet QuartzSpectrography

10. Anyothersuitableexperiments

11. Anyotherexperimentsthatmaybesetupfromtimetotime.

ReferenceBooks:

- ✓ *Elements ofModern Physics: Laboratory (BPHEL-142, Prepared by: Ignou: school ofscience (https://egyankosh.ac.in)*
- ✓ *Modern Physics Lab (PHYS340) Prepared by: Purdue University, (https://www.physics.putrdue*

Core XXI

QUANTUM MECHANICS-II

Course Outcomes

- Master the principles of solving motion in a spherically symmetric field.
- Acquire proficiency in utilizing approximate methods.
- Comprehend advanced techniques like the Variational method, W. K. B. method, and Time- dependent perturbation theory.
- Gain insight into Time-dependent perturbation theory and the scattering of identical particles.

Unit I Motion in a spherically symmetric field:

The hydrogen atom, Reduction to equivalent one body problem, radial equation, Energy eigenvalues and eigen functions, Degeneracy, Radial probability distribution, free-particle problem, Expression of plane waves in terms of spherical waves. Bound states of a 3-D square well.

Unit II Approximate methods:

stationary perturbation theory, Rayleigh Schrodinger method for non-degenerate case, first and second order perturbation, an harmonic oscillator, general theory for the degenerate case, removalof degeneracy, linear Stark effect, normal Zeeman effect**.**

Unit III

- **Variationalmethod**: Ground State, First Excited State and Second Excited State of H- atom One-Dimensional Harmonic Oscillator, and He-atom.
- **W. K. B. method**: Connection formulas, Bohr-Sommerfeld quantization rule, Harmonic oscillatorand cold emission**.**
- **Time-dependent perturbation theory:** Transition probability, constant and harmonic perturbation, Fermi Golden rule

Unit IV

Scattering amplitude and scattering cross section:

Born approximation, application to Coulomb and screened Coulomb potentials. Partial wave analysis for scattering, optical theorem, scattering from a hard sphere, resonant scattering from a square well potential. Identical particles, Symmetric and anti-symmetric wave function, Scattering of identical particles.

Text Book: *" Quantum Mechanics:Concepts and Applications" by NouredineZettile John Wiley and sons.*

Reference Books:

- ✓ *"Quantum Mechanics",L.I. Schiff 3rdEd, McGraw Hill Book Co.*
- ✓ *"Quantum Mechanics"E. Merzbacher , 2ndEd., John Wiley &Sons.*
- ✓ *"Quantum Physics", S.Gasiorowicz John Wiley.*
- ✓ *"A TextBook of Quantum Mechanics" by P.M. Mathews .andVenkatesan , Tata McGraw Hill.*
- ✓ *Introduction to Quantum Mechanics, by D.J.Griffiths ,2nd edition ,Pearson Publications.*

Core XXII **Electronics**

Course Outcomes (Cos)

- Enhance understanding of Network Analysis, Bipolar Junction Transistors, and Operational Amplifiers.
- Acquire knowledge of Oscillator circuits and their functionality.
- Master the concepts of Digital Circuits and their applications.
- Comprehend the operation and usage of Optoelectronic Devices in electronic systems.

Unit I

- **Network Analysis:** Superposition principle Thevenin and Norton Theorems, BJT, FET,MOSFET: characteristic, biasing-parameter analysis Feedback Circuits. Operational
- **Amplifiers:** The differential amplifier, D.C. and A.C. signal analysis, integral amplifier, rejection of common mode signals, CMMR, The operational amplifier, input and output impedances, Application of operational Amplifiers unit gain buffer, summing, integrating amplifier, Comparator, Operational amplifier as a differentiato**r.**

Unit II

Oscillator circuits: Feedback criteria for oscillation, Nyquist criterion, Phase shift, Wien-Bridge oscillator, Crystal controlled oscillator

Unit III

Digital Circuits: Logic fundamentals, Booleantheorem, logicgates: AND, OR, NOT, NOR,NAND XOR, and EXNOR.RTL, DTL and TTL logic, Flip-flop, RS-and JK-Flip flop, A/D and D/A Convertors 79

Unit IVOptoelectrics Device:

Principle of optical sources, Source material, Choice of materials, Internal and external quantum efficiency of L.E.D., Structures, Types of L.E.D.: Surface emitting L.E.D., Edge emitting L.E.D., Modulation capability, emission pattern, power bandwidth product, laser Diode Modes, Threshold condition, resonant frequency, Laser Diode Structure, Brief description of principle of optical detectors, Photomultipliers P.I.N. and A.P.D. configuration, Solar Cell.

Textbooks and Reading materials

- ✓ *Electronic fundamental and application by J.D. Ryder, PHI, Learning Pvt Ltd.*
- ✓ *Electronics: Circuits and Analysis, D.C.Dubey, Alpha Science*
- ✓ *R.P.Khare, Fiber Optics and Optoelectronics, Oxford University Press*

Reference Books:

- ✓ *Foundation of electronics – Chattopadhyay, Rakshit, Saha and Purkait , New age International publisher*
- ✓ *Electronics principles-Albert Malvino, Tata McGraw-Hill Edition*
- ✓ *Modern Digital Electronics-R.P Jain, Tata McGraw-Hill Edition*

Core XXIII

Laboratory: Optics and Modern Physics Lab (4 credit)

The main objectives of thislaboratory course are:
1. To apply the principles of optics, electronics, and modern physics in conducting experiments.
2. To gain a better understanding of theoretical principles through hands-on experimentation.

N.B:*Following is the list of some experiment however, the college can add any other experiments as per the convince.*

Optics &Modern Physics:

1. Determination of Boltzmann constant using V-I characteristics of PN diode.
2. Determination of Planck's constant using LEDs at least four colors.
3. Determination of e/m by Bar magnet/magnetic focus sung
4. Study of photo-electric effect.
5. Study of diffraction pattern of single and double slits using laser source and determination of its wavelength.
6. Study the electrical resistance as a function of temperature.
7. Fabry Perot interferometer Polarization Experiments Babinet compensator Edsar-Butlerbands Quarter wave plate Mallus Law Study of elliptical polarized light
8. Constant Deviation Spectrography Calibration Zeeman effect
9. Babinet Quartz Spectrography
10. Any other suitable experiments
11. Any other experiments that may be set up from time to time.

Reference Books:

- ✓ Elements of Modern Physics: Laboratory (BPHEL-142,
  Prepared by: Ignou: school of science (https://egyankosh.ac.in)
- ✓ Modern Physics Lab (PHYS 340)
  Prepared by: Purdue University, (https://www.physics.putrdue.edu)