**CURRICULUM AND CREDIT FRAMEWORK
FORUNDERGRADUATEPROGRAMME**

Department of Physics

NAGALAND UNIVERSITY

2023

**Approved by 36th Academic Council
(on 17th May, 2023)**

MajorCourse(Corepapers)

PaperCode	CourseCode	Titleofthepaper	TotalCredit
SEMESTER – 1			
C-1(T) C-1(P)	PHYC-101	MathematicalPhysics– I	3(T)+ 1 (P)= 4
C-2(T) C-2(P)	PHYC-102	Mechanics	3(T)+ 1 (P)= 4
SEMESTER – 2			
C-3(T) C-3(P)	PHYC-201	DigitalSystems andApplications	3(T)+ 1 (P)= 4
C-4(T) C-4(P)	PHYC-202	WavesandOptics	3(T)+ 1 (P)= 4
SEMESTER – 3			
C-5(T) C-5(P)	PHYC-301	MathematicalPhysics– II	3(T)+ 1 (P)= 4
C-6(T) C-6(P)	PHYC-302	Electricityand Magnetism	3(T)+ 1 (P)= 4
SEMESTER – 4			
C-7(T) C-7(P)	PHYC-401	AnalogSystemsandApplications	3(T)+ 1 (P)= 4
C-8(T) C-8(P)	PHYC-402(A) OR PHYC-402(B)	MathematicalPhysics– III OR Communication System	3(T)+ 1 (P)= 4
SEMESTER – 5			
C-9(T) C-9(P)	PHYC-501	ElementsofModernPhysics	3(T)+ 1 (P)= 4
C-10(T) C-10(P)	PHYC-502	ThermalPhysics	3(T)+ 1 (P)= 4
C-11(T) C-11(P)	PHYC-503	QuantumMechanics and Applications	3(T)+ 1 (P)= 4
SEMESTER – 6			
C-12(T) C-12(P)	PHYC-601	StatisticalMechanics	3(T)+ 1 (P)= 4
C-13(T) C-13(P)	PHYC-602	ElectromagneticTheory	3(T)+ 1 (P)= 4
C-14(T) C-14(P)	PHYC-603	SolidStatePhysics	3(T)+ 1 (P)= 4
C-15(T) C-15(P)	PHYC-604(A)OR PHYC-604(B)	Experimental TechniquesOR Physics of Devices andCommunicationsSystems	3(T)+1(Tu)=4 OR 3(T)+ 1 (P)= 4
SEMESTER – 7			
C-16(T)	PHYC-	Nuclear and Particle	3 (T) + 1 (Tu) = 4

C-16(P)	701(A)OR PHYC-701(B)	PhysicsOR ClassicalDynamics	OR 3(T)+1(P)= 4

C-17(T)	PHYC-702(A)OR PHYC-702(B)	Astronomy and AstrophysicsOR AppliedDynamics	3 (T) + 1 (Tu) =4 OR 3(T)+ 1 (P)= 4
C-17(P)			
C-18(T)	PHYC-703	The course may be planned in due course of time.	3 (T) + 1 (Tu) = 4 OR 3(T)+ 1 (P)= 4
C-18(P)			
C-19(T)	PHYC-704	Research Methodology	3 (T) + 1 (Tu) =4 OR 3(T)+ 1 (P)= 4
C-19(P)			
SEMESTER – 8 **The Department may offer either C-20 or C-21+C-22+C-23**			
C-20	PHYC-801	Dissertation	12 (Starts In Semester-7)
C-21	PHYC-802		4
C-22	PHYC-803		4
C-23	PHYC-804		4

SKILLENHANCEMENTCOURSES(3CreditEach)

Skill EnhancementCourses	Titleofthepaper	TotalCredit 3	Proposedby Department
	RenewableEnergyand EnergyHarvesting	3	
	WeatherForecasting	3	
	Radiationsafety	3	

CORECOURSES

SemesterI

C-1(T)　　　PHYC-101MATHEMATICALPHYSIC S-I

(Credits:Theory-03,Practicals-01)

Theemphasisofthecourseisonapplicationsinsolvingproblemsofinteresttophysicists.Thestudentsaretobeexaminedentirelyonthebasisofproblems,seenandunseen.

Unit-1
Calculus:
Recapitulation:

Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions, Intuitiveideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor andbinomialseries(statementsonly).

(2Lectures)

FirstOrderandSecondOrderDifferentialequations:

FirstOrderDifferential Equations and Integrating Factor. Homogeneous Equations with constantcoefficients.

(7 Lectures)

Unit-2
Calculusoffunctionsofmorethanonevariable:

Partialderivatives,exactandinexactdifferentials.Integratingfactor,withsimpleillustration.

(5Lectures)

IntroductiontoProbability:

Independent random variables: Probability distribution functions; Binomial, Gaussian, and Poisson,with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem andtheideaofhypothesistesting.

(4Lectures)

Unit-3
Vector Calculus:
Recapitulationofvectors
:

Scalarproductanditsinvarianceunderrotations.Vectorproduct,Scalartripleproductandtheirinterpretationin termsofareaand volume respectively.ScalarandVector fields.

(4Lectures)

VectorDifferentiation:

Directionalderivativesandnormalderivative.Gradientofascalarfield.DivergenceandCurlofavectorfield.DelandLaplacianoperators.

(5Lectures)

Unit-4

VectorIntegration:

Notion of infinitesimal line, surface andvolume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss'divergencetheorem,Green's,andStokesTheorems.

(10Lectures)

Unit-5

OrthogonalCurvilinearCoordinates:

OrthogonalCurvilinearCoordinates.DerivationofGradient,Divergence,CurlandLaplacianinCartesian,SphericalandCylindricalCoordinateSystems.

(6Lectures)

DiracDelta Functionand itsProperties:

DefinitionofDiracdeltafunction.RepresentationaslimitofaGaussianfunctionandrectangularfunction.PropertiesofDiracdeltafunction.

(2Lectures)

ReferenceBooks:

- MathematicalMethodsforPhysicists,G.B.Arfken,H.J.Weber,F.E.Harris,2013,7thEdn.,Elsevier.
- AnIntroductiontoOrdinaryDifferentialEquations,E.A.Coddington,2009,PHIlearning
- DifferentialEquations,GeorgeF.Simmons,2007,McGrawHill.
- MathematicalToolsforPhysics,JamesNearing,2010,DoverPublications.
- MathematicalmethodsforScientistsandEngineers,D.A.McQuarrie,2003,VivaBook
- AdvancedEngineeringMathematics,D.G.ZillandW.S.Wright,5Ed.,2012,JonesandBartlett Learning
- MathematicalPhysics,Goswami,1stedition,CengageLearning
- EngineeringMathematics,S.PalandS.C.Bhunia,2015,OxfordUniversityPress
- AdvancedEngineeringMathematics,ErwinKreyszig,2008,WileyIndia.
- EssentialMathematicalMethods,K.F.Riley&M.P.Hobson,2011,CambridgeUniv.Press.
- MathematicalMethodsinthePhysicalSciences,MaryL.Boas,Wiley-India

----

PHYSICSLAB

C-1(P)   PHYC-101

MATHEMATICALPHYSICS-I

TheaimofthisLabisnotjusttoteachcomputerprogrammingandnumericalanalysisbuttoemphasizeitsroleinsolvingproblems inPhysics.

- *Highlightstheuseofcomputationalmethodstosolvephysicalproblems*
- *Thecoursewillconsistoflectures(boththeoryandpractical)intheLab*
- *Evaluationdonenotontheprogrammingbutonthebasisofformulatingtheproblem*
- *Aimatteachingstudentstoconstructthecomputationalproblemtobesolved*
- *StudentscanuseanyoneoperatingsystemLinuxorMicrosoftWindows*

Topics	DescriptionwithApplications
IntroductionandOverview	Computerarchitectureandorganization,memory andInput/outputdevices
Basicsofscientificcomputing	Binaryanddecimalarithmetic,Floatingpointnumbers, algorithms,Sequence,SelectionandRepetition,single anddoubleprecisionarithmetic,underflow&overflow - emphasizetheimportanceofmakingequationsinterms ofdimensionless variables,Iterativemethods
ErrorsanderrorAnalysis	Truncationandroundofferrors,Absoluteand relativeerrors,Floatingpointcomputations.
ReviewofC&C++Programmingfundamentals	IntroductiontoProgramming,constants,variablesand datatypes,operatorsandexpressions,I/Ostatements,scanfandprintf,cinandcout,Manipulatorsfordataformatting,Controlstatements(decisionmakingandloopingstatements)(If-statement.If-elseStatement. NestedifStructure.Else-ifStatement.TernaryOperator.GotoStatement.SwitchStatement.UnconditionalandConditionalLooping. WhileLoop.Do-WhileLoop.FORLoop.BreakandContinue Statements. Nested Loops),Arrays(1D&2D)andstrings,userdefinedfunctions, StructuresandUnions,Ideaofclassesandobjects
Programs:	Sum&averageofalistofnumbers,largestofagivenlistofnumbersanditslocationinthelist,sortingofnumbersin ascendingdescendingorder, Binarysearch
Randomnumbergeneration	Areaofcircle,areaofsquare,volumeofsphere, valueofpi(u)
SolutionofAlgebraicandTranscendentalequationsbyBisection,NewtonRaphson andSecantmethods	Solutionoflinearandquadraticequations,solving $=\tan$;I=$I_0\left(\dfrac{\sin a}{a}\right)^2$ inoptics

Interpolation by Newton GregoryForward and Backward differenceformula,Errorestimation oflinear interpolation	Evaluationoftrigonometricfunctionse.g.$sin\theta,cos\theta,$ $tan\theta,etc.$
Numericaldifferentiation(Forwardand Backwarddifferenceformula)andInteg ration(TrapezoidalandSimpsonrules), MonteCarlo method	Given position with equidistant time data tocalculate velocity and acceleration and viceversa.FindtheareaofB-HHysteresisloop
SolutionofOrdinaryDifferentialEquatio ns(ODE) FirstorderDifferentialequationEuler, modifiedEulerandRunge-Kutta(RK)secondandfourthordermet hods	Firstorderdifferentialequation ● Radioactivedecay ● CurrentinRC,LCcircuitswithDCsource ● Newton'slawofcooling ● Classicalequationsofmotion AttemptfollowingproblemsusingRK4ordermethod: ● Solvethecoupleddifferentialequations $\frac{dx}{dt}=y+x-\frac{x^3}{3};\frac{dy}{dx}=-x$ forfourinitialconditions $x(0)=0,y(0)=-1,-2,-3,-4$ Plotxvsyforeachofthefourinitialconditionsont hesamescreenfor$0\leq t\leq15$ Thedifferentialequationdescribingthemotionof apendulumis $\frac{d\theta^2}{dt^2}=-sin\theta$.Thependulumis releasedfromrestatanangulardisplacement$a$, i.e.$\theta(0)=a$and$\theta'(0)=0$.Solvetheequationfor$a = 0.1$, 0.5 and 1.0 and plot θ as a function oftimeintherange$0\leq t\leq8\pi$.Alsoplottheanalytic solutionvalidforsmallθ,$(sin\theta=\theta)$

ReferredBooks:
- IntroductiontoNumericalAnalysis,S.S.Sastry,5[th]Edn.,2012,PHILearningPvt.Ltd.
- Schaum'sOutlineofProgrammingwithC++.J.Hubbard,2000,McGraw-HillPub.
- NumericalRecipesinC:TheArtofScientificComputing,W.H.Press*etal*,3[rd]Edn.,2007,Cambridge UniversityPress.
- AFirstCourseinNumericalMethods,U.M.Ascher&C.Greif,2012,PHILearning.
- ElementaryNumericalAnalysis,K.E.Atkinson,3[rd]Edn.,2007,WileyIndiaEdition.
- NumericalMethodsforScientists&Engineers,R.W.Hamming,1973,CourierDoverPub.
- AnIntroductiontoComputationalPhysics,T.Pang,2[nd]Edn.,2006,CambridgeUniv.Press
- ComputationalPhysics,DarrenWalker,1[st]Edn.,2015,ScientificInternationalPvt.Ltd.

C-2(T)   PHYC-102

MECHANICS

(Credits: Theory-03, Practicals-01)

Unit-1
FundamentalsofDynamics:
Reference frames. Inertial frames.Galilean transformations;Galileaninvariance.Momentumof variable-mass system:motionof rocket.Motionof a projectileinauniform gravitational field. Dynamics of a system of particles. Centre of Mass. Principle ofconservation ofmomentum.Impulse.

(5Lectures)

WorkandEnergy:
Workand Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy.Energydiagram.Stableandunstableequilibrium.Elasticpotentialenergy.Forceasgradient ofpotentialenergy.Work&Potentialenergy.Workdonebynon-conservativeforces.Lawofconservation   of Energy.

(4Lectures)

Unit-2
Collisions:
Elasticandinelasticcollisionsbetweenparticles.CentreofMassandLaboratoryframes.

(2Lectures)

RotationalDynamics:
Angularmomentumofa particle and a system of particles. Torque. Principle of conservation ofangularmomentum.Kineticenergyofrotation.Rotationabouta
fixedaxis.MomentofInertia.Calculationofmomentofinertiaforrectangular,cylindricalandsphericalbodies.

(7 Lectures)

Unit-3
GravitationandCentralForceMotion:
Lawofgravitation.Gravitationalpotentialenergy.Inertialandgravitationalmass.Potentialandfieldduetoaspherricalshellandsolidsphere.

(3 Lectures)

MotionofaParticleunderaCentralForceField. Two-bodyproblem and its reduction toone-body problem and its solution. The energy equation and energy diagram. Kepler's Laws.Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea ofglobalpositioningsystem(GPS).

(6Lectures)

Unit-4
Non-InertialSystems:
Non-inertialframesandfictitiousforces.Uniformlyrotatingframe.Lawsof Physics in rotatingcoordinatesystems.Centrifugalforce.Coriolisforceandits applications.

(3 Lectures)

SpecialTheoryofRelativity:
Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. LorentzTransformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativisticadditionofvelocities.Variation of mass with velocity. Massless Particles. Mass-energy Equivalence.

(6Lectures)

Unit-5
Oscillations:
SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy,potentialenergy,totalenergyandtheirtime-averagevalues.Dampedoscillation.Forcedoscillations. Resonance, sharpness of resonance andQualityFactor.

(5Lectures)

Elasticity:
RelationbetweenElasticconstants.TwistingtorqueonaCylinderorWire.

(2Lectures)

FluidMotion:
KinematicsofMovingFluids:Poiseuille'sEquationforFlowofaLiquidthroughaCapillaryTube.

(2Lectures)

ReferenceBooks:
- AnIntroductiontoMechanics,D.Kleppner,R.J.Kolenkow,1973,McGraw-Hill.
- Mechanics,BerkeleyPhysics,Vol.1,C.Kittel,W.Knight,et.al.2007,TataMcGraw-Hill.
- Physics,Resnick,HallidayandWalker8/e.2008,Wiley.
- AnalyticalMechanics,G.R.FowlesandG.L.Cassiday.2005,CengageLearning
- FeynmanLectures,Vol.I,R.P.Feynman,R.B.Leighton,M.Sands,2008,PearsonEducation
- IntroductiontoSpecialRelativity,R.Resnick,2005,JohnWileyandSons.
- UniversityPhysics,RonaldLaneReese,2003,ThomsonBrooks/Cole.
- IntroductiontoMechanics,MahendraKVerma,UniversitiesPress

AdditionalBooksforReference
- Mechanics,D.S.Mathur,S.ChandandCompanyLimited,2000
- UniversityPhysics.F.WSears,M.WZemansky,H.DYoung13/e,1986,AddisonWesley
- PhysicsforScientistsandEngineerswithModernPhys.,J.W.Jewett,R.A.Serway,2010,Cengage Learning
- TheoreticalMechanics,M.R.Spiegel,2006,TataMcGrawHill.

PHYSICS LAB

C-2(P)   PHYC-102

MECHANICS

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Reference Books:

- Advanced Practical Physics for Students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House
- Advanced Level Physics Practicals, Michael Nelson and Jon M.Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
- Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt.Ltd.
- Practical Physics, G.L.Squires, 2015, 4th Edition, Cambridge University Press.

SemesterII

C-3(T)   PHYC-201
DIGITALSYSTEMSANDAPPLICATIONS

(Credits: Theory-03, Practicals-01)

Unit-1
IntroductiontoCRO:
Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity.ApplicationsofCRO:(1)StudyofWaveform,(2)MeasurementofVoltage,Current,Frequency,andPhaseDifference.

(3Lectures)

IntegratedCircuits
(Qualitativetreatmentonly):Active&Passivecomponents.Discretecomponents.Wafer.Chip.Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea anddefinitionsonly).ClassificationofICs.

(2Lectures)

DigitalCircuits:
Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary toDecimalConversion.AND,ORandNOT6 Gates(realizations using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR andXNORGates.

(4Lectures)

Unit-2
Booleanalgebra:
DeMorgan'sTheorems.BooleanLaws.SimplificationofLogicCircuitusing   Boolean Algebra.FundamentalProducts.ConversionofaTruthtableintoEquivalentLogicCircuitby(1)SumofProductsMethodand(2)KarnaughMap

(5 Lectures)

Dataprocessingcircuits:
BasicideaofMultiplexers,Decoders,Encoders.

(2 Lectures)

ArithmeticCircuits:
BinaryAddition.BinarySubtraction.HalfandFullAdders.Half&Full Subtractors

(2 Lectures)

Unit-3
SequentialCircuits:
SR,D,andJKFlip-Flops.Clocked(LevelandEdgeTriggered)Flip-Flops.PresetandClearoperations.Race-aroundconditionsinJKFlip-Flop.M/SJKFlip-Flop.

(6Lectures)

Timers:
IC555:blockdiagramandapplications:AstablemultivibratorandMonostablemultivibrator.

(3Lectures)

Unit-4

Shiftregisters:
Serial-in-Serial-out,Serial-in-Parallel-out,Parallel-in-Serial-outandParallel-in-Parallel-outShiftRegisters(onlyupto4bits).

(2Lectures)

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

(4Lectures)

IntroductiontoAssemblyLanguage:
1byte,2byte&3byteinstructions.

(3 Lectures)

Unit-5

ComputerOrganization:
Input/outputDevices.Datastorage(ideaofRAMandROM).Computermemory.Memoryorganization&addressing.

(4 lectures)

Intel8085MicroprocessorArchitecture:
Mainfeaturesof8085.Blockdiagram.Components.Pin-outdiagram.Buses.Registers.ALU.Memory.Stackmemory.TimingandControlcircuitry.

(5 Lectures)

ReferenceBooks:

DigitalPrinciplesandApplications,A.P.Malvino,D.P.LeachandSaha,7thEd.,2011,TataMcGraw
FundamentalsofDigitalCircuits,AnandKumar,2ndEdn,2009,PHILearningPvt.Ltd.DigitalCircuitsandSystems,Venugopal,2011,TataMcGrawHill.
DigitalElectronics,GKKharate,2010,OxfordUniversityPress
DigitalSystems:Principles&Applications,R.J.Tocci,N.S.Widmer,2001,PHILearningLogicCircuitDesign,ShimonP.Vingron,2012,Springer.
DigitalElectronics,SubrataGhoshal,2012,CengageLearning.DigitalElectronics,S.K.Mandal,2010,1stedition,McGrawHill
MicroprocessorArchitectureProgramming&Applicationswith8085,2002,R.S.Goankar,PrenticeHall.

PHYSICS LAB

C-3(P)   PHYC-201
DIGITAL SYSTEMS AND APPLICATIONS

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. Write the following programs using 8085 Microprocessor
    a. Addition and subtraction of numbers using direct addressing mode
    b. Addition and subtraction of numbers using indirect addressing mode
    c. Multiplication by repeated addition.
    d. Division by repeated subtraction.
    e. Handling of 16-bit Numbers.
    f. Use of CALL and RETURN Instruction.
    g. Block data handling.
    h. Other programs (e.g. Parity Check, using interrupts, etc.).

Reference Books:

- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
- Basic Electronics: A Text Lab Manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1994, Mc-Graw Hill.
- Microprocessor Architecture Programming and applications with 8085, R.S.Goankar, 2002, Prentice Hall.
- Microprocessor 8085: Architecture, Programming and Interfacing, A.Wadhwa, 2010, PHI Learning.

C-4(T)   PHYC-202

WAVESANDOPTICS

(Credits: Theory-03, Practicals-01)

Unit-1

SuperpositionofCollinearHarmonicoscillations:
Superposition of two collinear oscillations having (1) equalfrequenciesand(2)differentfrequencies(Beats).SuperpositionofNcollinearHarmonicOscillationswith(1)equalphasedifferencesand(2)equalfrequencydifferences.

(4 Lectures)

SuperpositionoftwoperpendicularHarmonicOscillations:
GraphicalandAnalyticalMethods.LissajousFigureswithequalandunequal frequency and theiruses.

(2Lectures)

WaveMotion:
PlaneandSphericalWaves.LongitudinalandTransverse Waves. Plane Progressive (Travelling)Waves.WaveEquation.ParticleandWaveVelocities.DifferentialEquation.PressureofaLongitudinalWave.

(3 Lectures)

Unit-2

Velocity ofWaves:
VelocityofTransverseVibrationsofStretchedStrings.VelocityofLongitudinalWavesinaFluidinaPipe.Newton'sFormulaforVelocityofSound.Laplace'sCorrection.

(4 Lectures)

SuperpositionofTwoHarmonicWaves:
Standing(Stationary)Wavesina String: Fixed and Free Ends. Phase andGroupVelocities.ChangeswithrespecttoPositionandTime.EnergyofVibratingString.Transferof Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment.LongitudinalStandingWavesandNormalModes.

(5 Lectures)

Unit-3

WaveOptics:
Electromagneticnatureoflight.Definitionandpropertiesofwavefront.HuygensPrinciple.TemporalandSpatialCoherence.

(3Lectures)

Interference:
Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel'sBiprism.Phasechangeonreflection:Stokes'treatment.Interference in Thin Films,Newton'sRings:Measurementofwavelengthandrefractiveindex.

(6Lectures)

Unit-4

Interferometers:

MichelsonInterferometer-
(1)Ideaofformoffringes(Notheoryrequired),(2)DeterminationofWavelength,(3)WavelengthDifference,(4)RefractiveIndex,and(5)VisibilityofFringes.

(3Lectures)

Diffraction:

Kirchhoff'sIntegralTheorem,Fresnel-Kirchhoff'sIntegralformula.(Qualitativediscussiononly)

(2Lectures)

Fraunhoferdiffraction:

Singleslit.Circularaperture,ResolvingPowerofatelescope.Doubleslit.Diffractiongrating.Resolvingpower ofgrating.

(4 Lectures)

Unit-5

FresnelDiffraction:

Fresnel'sAssumptions.Fresnel'sHalf-PeriodZonesforPlaneWave.   Explanation   of RectilinearPropagationofLight.Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral,Fresneldiffractionpatternofastraightedge.

(6 Lectures)

Holography:

PrincipleofHolography.RecordingandReconstructionMethod.TheoryofHolographyasInterferencebetwe entwoPlaneWaves.Pointsourceholograms.   **(3Lectures)**

ReferenceBooks:

Waves:BerkeleyPhysicsCourse,Vol.3,FrancisCrawford,2007,TataMcGraw-Hill.FundamentalsofOptics,F.A.JenkinsandH.E.White,1981,McGraw-Hill PrinciplesofOptics,MaxBornandEmilWolf,7thEdn.,1999,PergamonPress.Optics,Ajo yGhatak,2008,TataMcGrawHill ThePhysicsofVibrationsandWaves,H.J.Pain,2013,JohnWileyandSons.ThePhysicsof WavesandOscillations,N.K.Bajaj,1998,TataMcGrawHill.FundamentalofOptics,A.K umar,H.R.GulatiandD.R.Khanna,2011,R.ChandPublications.

- -

PHYSICS LAB

C-4(P)   PHYC-202

WAVES AND OPTICS

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2–T law.
2. To investigate the motion of Coupled Oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster's focusing; determination of angle of prism.
5. To determine the refractive index of the material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of Sodium source using Michelson's interferometer.
8. To determine the wavelength of Sodium light using Fresnel Biprism.
9. To determine the wavelength of Sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine the wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine the dispersive power and resolving power of a plane diffraction grating.

Reference Books:

Advanced Practical Physics for Students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House
A TextBook of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal Advanced Level Physics Practicals, Michael Nelson and Jon M.Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal, 1985, Vani Pub.

C-5(T)   PHYC-301
MATHEMATICALPHYSICS-II

(Credits:Theory-03,Practicals-01)

Theemphasisofthecourseisonapplicationsinsolvingproblemsofinteresttophysicists.Studentsaretobeexaminedonthebasisofproblems,seenandunseen.

Unit-1
Fourier Series:
Periodicfunctions.Orthogonalityofsineandcosinefunctions,DirichletConditions(Statementonly).
Expansion of periodic functions in a series of sine and cosine functions and determination ofFouriercoefficients.ComplexrepresentationofFourierseries.Expansionoffunctionswitharbitrary
period. Expansion of non-periodic functions over an interval. Even and odd functions andtheirFourierexpansions.

(9 Lectures)

Unit-2
FrobeniusMethodandSpecialFunctions:
SingularPointsofSecondOrderLinearDifferentialEquationsandtheirimportance.Frobeniusmethod.Legendre,Bessel,HermiteandLaguerreDifferential Equations.

(9 Lectures)

Unit-3
Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality.Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. BesselFunctions of the First Kind.

(9 Lectures)

Unit-4
PartialDifferentialEquations:
Solutionstopartialdifferentialequations,usingseparationofvariables:Laplace'sEquationinproblemsofrectangular,cylindricaland spherical symmetry. Wave equation and its solution forvibrationalmodesofastretchedstring.

(9 Lectures)

Unit-5
SomeSpecialIntegrals:
BetaandGammaFunctionsandRelationbetweenthem.ExpressionofIntegralsintermsofGammaFunctions. ErrorFunction(ProbabilityIntegral).

(4Lectures)

TheoryofErrors:
SystematicandRandomErrors.PropagationofErrors.NormalLawofErrors.StandardandProbableError.Least-squaresfit.

(5 Lectures)

ReferenceBooks:

- MathematicalMethodsforPhysicists:Arfken,Weber,2005,Harris,Elsevier.
- FourierAnalysis,M.R.Spiegel,2004,TataMcGraw-Hill.
- MathematicsforPhysicists,SusanM.Lea,2004,ThomsonBrooks/Cole.
- DifferentialEquations,GeorgeF.Simmons,2006,TataMcGraw-Hill.
- PartialDifferentialEquationsforScientists&Engineers,S.J.Farlow,1993,DoverPub.
- EngineeringMathematics,S.PalandS.C.Bhunia,2015,OxfordUniversityPress
- MathematicalMethodsforScientists&Engineers,D.A.McQuarrie,2003,VivaBooks
- MathematicalMethodsinthePhysicalSciences,MaryL.Boas,Wiley-India

----

PHYSICS LAB

C-5(P)   PHYC-301

MATHEMATICALPHYSICS-II

The aimof this Lab isto use computational methods to solve physical problems. The course willconsistoflectures(boththeoryandpractical)intheLab.Evaluationdonenotontheprogrammingbutonthe basisofformulatingtheproblem

Topics	DescriptionwithApplications
Introduction to NumericalcomputationsoftwareScilab/Python	Introduction to Scilab, Advantages anddisadvantages, Scilabenvironment,Commandwindow,Figurewindow,Editwindow,Variablesand arrays,InitialisingvariablesinScilab, Multidimensionalarrays,Subarray,Special values,Displayingoutputdata,datafile,Scalarandarrayoperations,Hierarchyofoperations,BuiltinScilabfunctions,Introductiontoplotting,2Dand3Dplotting(2),Branching Statements and program design,Relational&logicaloperators,thewhileloop,forloop,detailsofloopoperations,break&continuestatements,nested loops,logicalarraysandvectorization (2) User defined functions,Introductionto Scilabfunctions, VariablepassinginScilab,optionalarguments,preservingdatabetweencallsto a function, Complex and Characterdata,stringfunction,Multidimensionalarrays (2)anintroductiontoScilabfileprocessing,fileopening and closing, Binary I/o functions,comparing binary and formatted functions,Numericalmethodsanddevelopingtheskillsof writingaprogram(2).
Curvefitting,Leastsquarefit, Goodnessoffit,standarddeviation	Ohm'slawtocalculateR,Hooke'slawtocalculate SpringConstant
SolutionofLinearsystemofequationsbyGausseliminationmethodandGaussSeidalmethod.Diagonalization of matrices, Inverseofamatrix,Eigenvectors,eigenvalueproblems	Solutionofmeshequationsofelectric circuits (3meshes) Solutionofcoupledspringmasssystems(3masses)
GenerationofSpecialfunctionsusingUserdefinedfunctionsin Scilab	GeneratingandplottingLegendrePolynomialsGenerating andplottingBesselfunction

Solution of ODE	• First order differential equation
	• Radioactive decay
First order Differential equation Euler, modified Euler and Runge-Kutta second order methods	• Current in RC, LC circuits with DC source
	• Newton's law of cooling
	• Classical equations of motion Second order Differential Equation
Second order differential equation Fixed difference method Partial differential equations	• Harmonic oscillator (no friction)
	• Damped Harmonic oscillator
	• Overdamped
	• Critical damped
	• Oscillatory
	• Forced Harmonic oscillator
	• Transient and
	• Steady state solution
	• Apply above to LCR circuits also
	• Solve $x^2\dfrac{d^2y}{dx^2} - 4x(1+x)\dfrac{dy}{dx} + 2(1+x)y = x^3$ with the boundary conditions at $x=1, y=\tfrac{1}{2}e^2, \dfrac{dy}{dx}=-\dfrac{3}{2}e^2 - 0.5$ in the range $1 \le x \le 3$. Plot y and $\dfrac{dy}{dx}$ against x in the given range on the same graph.
	Partial Differential Equation:
	• Wave equation
	• Heat equation
	• Poisson equation
	• Laplace equation
Using Scicos/xcos	• Generating square wave, sine wave, sawtooth wave
	• Solution to harmonic oscillator
	• Study of beat phenomenon
	• Phase space plots

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P.Hobson and S.J.Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- First Course in Complex Analysis with Applications, D.G.Zill and P.D.Shanahan, 1940, Jones & Bartlett
- Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt.Ltd.
- A Guide to MATLAB, B.R.Hunt, R.L.Lipsman, J.M.Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V.Wouwer, P.Saucez, C.V.Fernández.2014 Springer
- Scilab by example: M.Affouf 2012, ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair.2011 S.Chand & Company
- Scilab Image Processing: Lambert M.Surhone.2010 Betascript Publishing
- www.scilab.in/textbook_companion/generate_book/291

C-6(T)   PHYC-302 ELECTRICITY AND MAGNETISM

(Credits: Theory-03, Practicals-01)

Unit-1
Electric Field and Electric Potential
Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

(4 Lectures)

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.

(5 Lectures)

Unit-2
Electrostatics
Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor.

(5 Lectures)

Dielectric Properties of Matter:
Electric Field in matter. Polarization. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics.

(5 Lectures)

Unit-3
Magnetic Field:
Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Torque on a current loop in a uniform Magnetic Field.

(5 Lectures)

Magnetic Properties of Matter:
Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism. B-H curve and hysteresis.

(4 Lectures)

Unit-4

ElectromagneticInduction:

Faraday's Law. Lenz's Law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. EnergystoredinaMagneticField.IntroductiontoMaxwell'sEquations.ChargeConservationandDisplacementcurrent.

(6Lectures)

BallisticGalvanometer:

TorqueonacurrentLoop.BallisticGalvanometer:CurrentandChargeSensitivity.Electromagneticdamping. Logarithmicdamping.CDR.

(3Lectures)

Unit-5

ElectricalCircuits:

ACCircuits:Kirchhoff'slawsforACcircuits. Complex Reactance and Impedance. Series LCRCircuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. ParallelLCRCircuit.

(4Lectures)

Networktheorems:

IdealConstant-voltageandConstant-currentSources.NetworkTheorems:Thevenintheorem,Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem.Applicationstodccircuits.

(4Lectures)

ReferenceBooks:

Electricity,Magnetism&ElectromagneticTheory,S.MahajanandChoudhury,2012,TataMcGraw
ElectricityandMagnetism,EdwardM.Purcell,1986McGraw-
HillEducationIntroductiontoElectrodynamics,D.J.Griffiths,3rdEdn.,1998,BenjaminCum
mings.
FeynmanLecturesVol.2,R.P.Feynman,R.B.Leighton,M.Sands,2008,PearsonEducationElements
ofElectromagnetics,M.N.O.Sadiku,2010,OxfordUniversityPress.
ElectricityandMagnetism,J.H.Fewkes&J.Yarwood.Vol.I,1991,OxfordUniv.Press.

- -

PHYSICS LAB

C-6(P)　　　　　　PHYC-302

ELECTRICITYANDMAGNETISM

1. UseaMultimeterformeasuring(a)Resistances,(b)ACandDCVoltages,(c)DCCurrent, (d)Capacitances,and(e)Checkingelectricalfuses.
2. TostudythecharacteristicsofaseriesRCCircuit.
3. TodetermineanunknownLowResistanceusingPotentiometer.
4. TodetermineanunknownLowResistanceusingCareyFoster'sBridge.
5. TocomparecapacitancesusingDe'Sauty'sbridge.
6. MeasurementoffieldstrengthBanditsvariationinasolenoid(determinedB/dx)
7. ToverifytheTheveninandNortontheorems.
8. ToverifytheSuperposition,andMaximumpowertransfertheorems.
9. TodetermineselfinductanceofacoilbyAnderson'sbridge.
10. TostudyresponsecurveofaSeriesLCRcircuitanddetermineits(a)Resonantfrequency, (b)Impedanceatresonance,(c)QualityfactorQ,and(d)Bandwidth.
11. TostudytheresponsecurveofaparallelLCRcircuitanddetermineits(a)Anti-resonantfrequencyand(b) QualityfactorQ.
12. MeasurementofchargeandcurrentsensitivityandCDRofBallisticGalvanometer
13. DetermineahighresistancebyleakagemethodusingBallisticGalvanometer.
14. Todetermineself-inductanceofacoilbyRayleigh'smethod.
15. TodeterminethemutualinductanceoftwocoilsbyAbsolutemethod.

ReferenceBooks:

AdvancedPracticalPhysicsforStudents,B.L.FlintandH.T.Worsnop,1971,AsiaPublishingHouse
ATextBookofPracticalPhysics,I.Prakash&Ramakrishna,11[th]Ed.,2011,KitabMahalAdvancedLe velPhysicsPracticals,MichaelNelsonandJonM.Ogborn,4[th]Edition,reprinted1985,HeinemannE ducationalPublishers
EngineeringPracticalPhysics,S.PanigrahiandB.Mallick,2015,CengageLearning.
ALaboratoryManualofPhysicsforUndergraduateClasses,D.P.Khandelwal,1985,VaniPub.

SemesterIV

C-7(T)   PHYC-401
ANALOGSYSTEMSANDAPPLICATIONS

(Credits: Theory-03, Practicals-01)

Unit-1
SemiconductorDiodes:
P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Driftvelocity.BarrierFormationinPNJunction Diode.StaticandDynamicResistance. Current Flow Mechanism in Forward and Reverse Biased Diode. DriftVelocity.DerivationforBarrierPotential,BarrierWidthand Current for Step Junction.

(9 Lectures)

Unit-2
Two-terminalDevicesandtheirApplications:
(1)RectifierDiode:Half-waveRectifiers.Centre-tappedandFull-waveRectifiers,CalculationofRippleFactorandRectificationEfficiency,(2) Zener Diode and VoltageRegulation.Principleandstructureof(1)LEDs,(2)Photodiodeand(3)SolarCell.

(5 Lectures)

BipolarJunctiontransistors:
n-p-nandp-n-pTransistors. Characteristics ofCB,CEandCCConfigurations.Currentgainsaandβ, Relations between a and β. Load Line analysis of Transistors. DC Load line and Q-point.

(4 Lectures)

Unit-3
Amplifiers:
TransistorBiasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as2-portNetwork.h-parameterEquivalentCircuit.Analysisofasingle-stageCEamplifierusingHybridModel.
Input and Output Impedance.Current, Voltage and Power Gains. Classification ofClassA,B&CAmplifiers.

(7 Lectures)

CoupledAmplifier: TwostageRC-coupledamplifieranditsfrequencyresponse.

Unit-4   **(2 Lectures)**
FeedbackinAmplifiers:
EffectsofPositiveandNegativeFeedbackonInputImpedance,OutputImpedance,Gain,Stability,DistortionandNoise.

(4Lectures)

SinusoidalOscillators
RCPhaseshiftoscillator,determinationofFrequency.Hartley&Colpittsoscillators.

(3 Lectures)

Conversion:
Resistivenetwork(WeightedandR-2RLadder).AccuracyandResolution.A/DConversion(successiveapproximation)

(2 Lectures)

Unit-5

OperationalAmplifiers

(Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop andClosed-loopGain.FrequencyResponse.CMRR.SlewRateandconceptofVirtualground.

(4Lectures)Appli

cationsofOp-Amps:(1)Invertingandnon-invertingamplifiers,(2)Adder,(3)Subtractor,
(4) Differentiator,(5)Integrator,(6)Weinbridgeoscillator.

(5Lectures)

ReferenceBooks:

- IntegratedElectronics,J.MillmanandC.C.Halkias,1991,TataMc-GrawHill.
- Electronics:FundamentalsandApplications,J.D.Ryder,2004,PrenticeHall.
- SolidStateElectronicDevices,B.G.Streetman&S.K.Banerjee,6thEdn.,2009,PHILearning
- ElectronicDevices&Circuits,S.Salivahanan&N.S.Kumar,3rdEd.,2012,TataMc-GrawHill
- OP-AmpsandLinearIntegratedCircuit,R.A.Gayakwad,4thedition,2000,PrenticeHall
- Microelectroniccircuits,A.S.Sedra,K.C.Smith,A.N.Chandorkar,2014,6thEdn.,OxfordUniversityPress.
- ElectronicCircuits:Handbookofdesign&applications,U.Tietze,C.Schenk,2008,Springer
- SemiconductorDevices:PhysicsandTechnology,S.M.Sze,2ndEd.,2002,WileyIndia
- MicroelectronicCircuits,M.H.Rashid,2ndEdition,CengageLearning
- ElectronicDevices,7/eThomasL.Floyd,2008,PearsonIndia

- -

PHYSICS LAB

C-7(P) PHYC-401
ANALOG SYSTEMS AND APPLICATIONS

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal Class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt's oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a $1^{st}/2^{nd}$ order differential equation.

Reference Books:
- Basic Electronics: A Text Lab Manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1994, Mc-GrawHill.
- OP-Amps and Linear Integrated Circuit, R.A.Gayakwad, 4th edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-GrawHill.
- Electronic Devices & Circuit Theory, R.L.Boylestad & L.D.Nashelsky, 2009, Pearson
----

C-8(T)   PHYC-402(A)
MATHEMATICALPHYSICS-III

(Credits:Theory-03,Practicals-01)

Theemphasisofthecourseisonapplicationsinsolvingproblemsofinteresttophysicists.Studentsaretobeexamined onthebasisofproblems,seenandunseen.

Unit-1
ComplexAnalysis:
BriefRevisionofComplexNumbersandtheirGraphicalRepresentation.Euler'sformula,DeMoivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Cauchy-RiemannConditions.

(9 Lectures)

Unit-2
Singularfunctions:polesandbranchpoints,orderofsingularity,branchcuts.Integrationofafunctionofa complexvariable.Cauchy'sInequality.Cauchy'sIntegralformula.

(5 Lectures)

Simply and multiply connected region.Laurent and Taylor's expansion. Residues and ResidueTheorem.

(4 Lectures)

Unit-3
IntegralsTransforms:
Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform oftrigonometric,Gaussian, finitewavetrain& other functions. Representation of Dirac delta functionasaFourierIntegral.Fouriertransformofderivatives,InverseFouriertransform.

(9 Lectures)

Unit-4
ApplicationofFourierTransformstodifferentialequations:OnedimensionalWaveandDiffusion/HeatFlowEquations.

(5 Lectures)

LaplaceTransforms:
LaplaceTransform(LT)ofElementaryfunctions.PropertiesofLTs:ChangeofScaleTheorem.

(4Lectures)

Unit-5
LTsof1stand2ndorderDerivativesandIntegralsofFunctions,
DerivativesandIntegralsof LTs. LT of Unit Step function, Dirac Delta function, PeriodicFunctions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2nd orderDifferentialEquations:DampedHarmonicOscillator,Coupleddifferentialequationsof1storder.

(9 Lectures)

ReferenceBooks:

MathematicalMethodsforPhysicsandEngineers,K.FRiley,M.P.HobsonandS.J.Bence,3rded.,2006,CambridgeUniversityPress

MathematicsforPhysicists,P.DenneryandA.Krzywicki,1967,DoverPublications

ComplexVariables,A.S.Fokas&M.J.Ablowitz,8thEd.,2011,CambridgeUniv.PressComplexVariables,A.K.Kapoor,2014,CambridgeUniv.Press

Complex Variablesand Applications, J.W. Brown& R.V.Churchill, 7th Ed. 2003, TataMcGraw-Hill

FirstCourseinComplexAnalysiswithApplications,D.G.ZillandP.D.Shanahan,1940,Jones&Bartlett

----

PHYSICS LAB

C-8(P)   PHYC-402(A)

MATHEMATICAL PHYSICS-III

Scilab/C^{++}/etc. based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations: $dy/dx = e^{-x}$ with $y=0$ for $x=0$ $dy/dx + e^{-x}y = x^2$
   $d^2y/dt^2 + 2dy/dt = -y$ $d^2y/dt^2 + e^{-t}dy/dt = -y$

2. Dirac Delta Function:

   Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{\frac{-(x-2)^2}{2\sigma^2}}(x+3)dx$ for $\sigma = 1, 0.1, 0.001$ and show it tends to 5.

3. Fourier Series: Program to sum $\sum\limits_{n=1}^{\infty}(0.2)^n$

   Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special functions:

   $\int\limits_{-1}^{1} P_n(\mu)P_m(\mu)d\mu = \delta_{n,m}$

   Plot $P_n(x), j_v(x)$

   Show recursion relation

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. *sin θ,* Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.

8. Compute the nth roots of unity for $n=2,3,$ and 4.

9. *Find the two square roots of* $-5+12j$.

10. Integral transform: FFT of e^{-x^2}

11. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.

12. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace's transform.

13. Perform circuit analysis of a general LCR circuit using Laplace's transform.

Reference Books:

MathematicalMethodsforPhysicsandEngineers,K.FRiley,M.P.HobsonandS.J.Bence,3rded.,2006,CambridgeUniversityPress

MathematicsforPhysicists,P.DenneryandA.Krzywicki,1967,DoverPublications

Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific andEngineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 SpringerISBN: 978-3319067896

AGuidetoMATLAB,B.R.Hunt,R.L.Lipsman,J.M.Rosenberg,2014,3rdEdn.,CambridgeUniversityPress

ScilabbyExample:M.Affouf,2012.ISBN:978-1479203444

Scilab(AfreesoftwaretoMatlab):H.Ramchandran,A.S.Nair.2011S.Chand&CompanyScilabImageProcessing:LambertM.Surhone.2010BetascriptPublishinghttps://web.stanford.edu/~boyd/ee102/laplace_ckts.pdfocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf

C-8(T)   PHYC-402(B)
COMMUNICATION SYSTEMS

(Credits:Theory-03,Practicals-01)
Theemphasisofthecourseisonapplicationsinsolvingproblemsofinteresttophysicists.Studentsaretobeexaminedontheb asisofproblems,seenandunseen.

Unit-1
Electroniccommunication:
Introduction to communication – means and modes. Need for modulation. Block diagram of anelectroniccommunicationsystem.Briefideaoffrequencyallocationforradiocommunicationsystem in India (TRAI). Electromagnetic communication spectrum, band designations and usage.Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio.

(8Lectures)
Unit-2
Analog Modulation:
AmplitudeModulation,modulationindexand frequency spectrum. Generation of AM (EmitterModulation),AmplitudeDemodulation(diodedetector),Concept of Single side band generationand detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index andfrequency spectrum, equivalence between FM and PM.

(9 Lectures)
Unit-3
Analog Pulse Modulation:
Channelcapacity,Samplingtheorem,BasicPrinciples-PAM,PWM,PPM,Multiplexing.

(4 Lectures)
Digital Pulse Modulation:
Needfordigitaltransmission,PulseCodeModulation,Digital Carrier Modulation Techniques,Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency ShiftKeying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).

(6 Lectures)
Unit-4
IntroductiontoCommunicationandNavigation systems:
SatelliteCommunication–Introduction,need,Geosynchronoussatelliteorbits,geostationarysatellite, advantages of geostationary satellites. Satellite visibility, transponders (C - Band),pathloss,groundstation,simplifiedblockdiagramofearthstation.

(9 Lectures)
Unit-5
MobileTelephonySystem
Basic concept of mobile communication, frequency bands used in mobile communication, conceptofcellsectoringandcellsplitting,SIMnumber,IMEInumber,architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA andFDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts(qualitative only).

GPS navigation system (qualitative idea only)**(9 Lectures)**

ReferenceBooks:
- Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
- AdvancedElectronicsCommunication Systems,Tomasi, 6thedition, PrenticeHall.
- ElectronicCommunicationsystems,G.Kennedy,3rdEdn.,1999,TataMcGrawHill.
- Principles of Electronic Communication Systems, Frenzel, 3rd edition, McGraw Hill
- CommunicationSystems,S.Haykin,2006,WileyIndia
- ElectronicCommunicationSystem,Blake,Cengage,5thedition.
- WirelessCommunications,AndreaGoldsmith,2015,CambridgeUniversityPress

PHYSICSLAB

C-8(P)   PHYC-402 (B)
COMMUNICATIONSYSTEMS

1. TodesignanAmplitudeModulator usingTransistor
2. Tostudy envelopedetectorfordemodulationofAMsignal
3. TostudyFMGeneratorandDetectorcircuit
4. TostudyAMTransmitterandReceiver
5. TostudyFMTransmitterandReceiver
6. TostudyTimeDivisionMultiplexing(TDM)
7. TostudyPulseAmplitudeModulation(PAM)
8. TostudyPulseWidthModulation(PWM)
9. TostudyPulsePositionModulation(PPM)
10. TostudyASK,PSKandFSK modulators

ReferenceBooks:
- ElectronicCommunicationSystems,G.Kennedy,1999,TataMcGrawHill.
- ElectronicCommunicationSystem,Blake,Cengage,5[th]edition.

C-9(T)   PHYC-501

ELEMENTSOFMODERNPHYSICS

(Credits: Theory-03, Practicals -01)

Unit-1
QuantumMechanics
Planck'squantum,Planck'sconstantandlightasa collection of photons; Blackbody Radiation:Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength andmatterwaves;Davisson-Germerexperiment.Wavedescriptionofparticlesbywavepackets.Groupand Phase velocities and relation between them.

(10Lectures)

Unit-2
Positionmeasurement
Gammaraymicroscopethoughtexperiment;Wave-particleduality,Heisenberguncertaintyprinciple(UncertaintyrelationsinvolvingCanonicalpairofvariables):DerivationfromWavePackets.

(3Lectures)

Twoslitinterferenceexperimentwithphotons,atomsandparticles;linearsuperpositionprincipleasaconsequence;Matterwavesandwaveamplitude;Schrodingerequationfornon-relativisticparticles;MomentumandEnergyoperators;stationarystates;physicalinterpretationofawavefunction,probabilitiesandnormalization.

(7Lectures)

Unit-3
OneDimensionalProblems
Onedimensionalinfinitelyrigidbox-energyeigenvaluesandeigenfunctions,normalization;Quantumdotasexample;Quantummechanical scattering and tunnelling in one dimension -acrossasteppotentialandrectangularpotentialbarrier.

(7Lectures)

Unit-4
NuclearPhysics
Sizeandstructureofatomicnucleusanditsrelationwithatomicweight;Impossibilityofanelectronbeinginthen ucleusas a consequence of the uncertainty principle. Nature of nuclear force,LiquidDropmodel:semi-empiricalmassformulaand binding energy, Nuclear ShellModel, andmagicnumbers.

(5Lectures)

Radioactivity
Stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay,energyreleased,spectrumandPauli'spredictionofneutrino;Gammarayemission,energy-momentumconservation.

(6Lectures)

Unit-5

Fissionandfusion

Massdeficit,relativityandgenerationofenergy;Fission- nature of fragments and emission ofneutrons. Nuclear reactor. Fusion and thermonuclearreactionsdrivingstellarenergy(briefqualitativediscussions).

(3Lectures)

Lasers:

Einstein'sAandBcoefficients.Metastablestates.SpontaneousandStimulatedemissions.OpticalPumpingan dPopulationInversion.Three-LevelandFour-LevelLasers.RubyLaserandHe-NeLaser.Basiclasing.

(4Lectures)

ReferenceBooks:

1. ConceptsofModernPhysics,ArthurBeiser,2002,McGraw-Hill.
2. IntroductiontoModernPhysics,RichMeyer,Kennard,Coop,2002,TataMcGrawHillIntroductiontoQuantu mMechanics,DavidJ.Griffith,2005,PearsonEducation.
3. PhysicsforScientistsandEngineerswithModernPhysics,JewettandSerway,2010,CengageLearning.
4. ModernPhysics,G.KaurandG.R.Pickrell,2014,McGrawHill
5. QuantumMechanics:Theory&Applications,A.K.Ghatak&S.Lokanathan,2004,Macmillan

AdditionalBooksforReference

ModernPhysics,J.R.Taylor,C.D.Zafiratos,M.A.Dubson,2004,PHILearning.

TheoryandProblemsofModernPhysics,Schaum`soutline,R.GautreauandW.Savin,2nd Edn,TataMcGraw-HillPublishingCo.Ltd.

QuantumPhysics,BerkeleyPhysics,Vol.4.E.H.Wichman,1971,TataMcGraw-HillCo.
BasicIdeasandConceptsinNuclearPhysics,K.Heyde,3rdEdn.,InstituteofPhysicsPub.
SixIdeasthatShapedPhysics:ParticleBehavelikeWaves,T.A.Moore,2003,McGrawHill
QuantumMechanics,R.EisbergandR.Resnick,JohnWiley&Sons.

PHYSICS LAB

C-9(P)   PHYC-501

ELEMENTSOFMODERNPHYSICS

1. MeasurementofPlanck'sconstantusingblackbodyradiationandphoto-detector
2. Photo-electriceffect:photocurrentversusintensityandwavelengthoflight;maximumenergyofphoto-electronsversusfrequencyoflight
3. Todetermineworkfunctionofmaterialoffilamentofdirectlyheatedvacuumdiode.
4. TodeterminePlanck'sconstantusingLEDsofatleast4differentcolours.
5. TodeterminethewavelengthofH-alphaemissionlineofHydrogenatom.
6. Todeterminetheionizationpotentialofmercury.
7. TodeterminetheabsorptionlinesintherotationalspectrumofIodinevapour.
8. Todeterminethevalueofe/mby(a)Magneticfocusingor(b)Barmagnet.
9. TosetuptheMillikanoildropapparatusanddeterminethechargeofanelectron.
10. ToshowthetunnelingeffectintunneldiodeusingI-Vcharacteristics.
11. Todeterminethewavelengthoflasersourceusingdiffractionofsingleslit.
12. Todeterminethewavelengthoflasersourceusingdiffractionofdoubleslits.
13. Todetermine(1)wavelengthand(2)angularspreadofHe-Nelaserusingplanediffractiongrating

ReferenceBooks

AdvancedPracticalPhysicsforStudents,B.L.FlintandH.T.Worsnop,1971,AsiaPublishingHouse

Advanced LevelPhysics Practicals, Michael Nelson and Jon M.Ogborn,4th Edition,reprinted1985,HeinemannEducationalPublishers

ATextBookofPracticalPhysics,I.Prakash&Ramakrishna,11[th]Edn,2011,KitabMahal

- -

C-10(T)   PHYC-502

THERMAL PHYSICS

(Credits:Theory-03,Practicals-01)

(Include related problems for each topic)

Unit-1
Introduction to Thermodynamics
Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics, and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_p and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion coefficient.

(7 Lectures)

Unit-2
Second Law of Thermodynamics
Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics

(7 Lectures)

Entropy
Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics.

(5 Lectures)

Unit-3
Thermodynamic Potentials
Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy. Their definitions, Properties and Applications. Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

(5 Lectures)

Maxwell's Thermodynamic Relations
Derivations and applications of Maxwell's Relations, (1) Clausius Clapeyron equation (2) Values of C_p-C_V (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Vander Waals Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

(5 Lectures)

Unit-4

KineticTheoryofGases

DistributionofVelocities:Maxwell-BoltzmannLaw ofDistributionofVelocitiesin an Ideal Gasand its Experimental Verification. Stern's Experiment.Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (Noproofrequired).SpecificheatsofGases.

(5Lectures)

MolecularCollisions:

MeanFreePath.CollisionProbability.EstimatesofMeanFreePath. Transport Phenomenon inIdeal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and itsSignificance.

(4Lectures)

Unit-5

RealGases:

Behaviorof Real Gases: Deviations from the Ideal Gas Equation.BoyleTemperature.VanderWaalsEquationofStateforRealGases.ValuesofCriticalConstants.La wofCorresponding States. P-V Diagrams.Joule'sExperiment.FreeAdiabaticExpansionofaPerfectGas.Joule-ThomsonPorousPlugExperiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion.Joule-ThomsonCooling.

(7Lectures)

ReferenceBooks:

HeatandThermodynamics,M.W.Zemansky,RichardDittman,1981,McGraw-Hill.ATreatiseonHeat,MeghnadSahaandB.N.Srivastava,1958,IndianPress

ThermalPhysics,S.Garg,R.BansalandGhosh,2ndEdition,1993,TataMcGraw-HillModern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.Thermodynamics,KineticTheory&StatisticalThermodynamics,Sears&Salinger.1988, Narosa.

ConceptsinThermalPhysics,S.J.BlundellandK.M.Blundell,2ndEd.,2012,OxfordUniversityPress ThermalPhysics,A.KumarandS.P.Taneja,2014,R.ChandPublications.ThermalPhysic s,B.K.Agrawal,LokBhartiPublications.

PHYSICSLAB

C-10(P)   PHYC-502THERMALPHYSICS

1. TodetermineMechanicalEquivalentofHeat,J,byCallenderandBarne'sconstantflowmethod.
2. TodeterminetheCoefficientofThermalConductivityofCubySearle'sApparatus.
3. TodeterminetheCoefficientofThermalConductivityofCubyAngstrom'sMethod.
4. TodeterminetheCoefficientofThermalConductivityofabadconductorbyLeeandCharlton'sdiscmethod.
5. TodeterminetheTemperatureCoefficientofResistancebyPlatinumResistanceThermometer(PRT).
6. TostudythevariationofThermo-EmfofaThermocouplewithDifferenceofTemperatureofitsTwoJunctions.
7. TocalibrateathermocoupletomeasuretemperatureinaspecifiedRangeusing
   (1) NullMethod,(2)DirectmeasurementusingOp-AmpdifferenceamplifierandtodetermineNeutralTemperature.

ReferenceBooks:

● AdvancedPracticalPhysicsforStudents,B.L.FlintandH.T.Worsnop,1971,AsiaPublishingHouse
● ATextBookofPracticalPhysics,I.Prakash&Ramakrishna,11thEd.,2011,KitabMahal
● Advanced LevelPhysics Practicals, Michael Nelson and Jon M.Ogborn,4th Edition,reprinted1985,HeinemannEducationalPublishers
● A LaboratoryManual of PhysicsforUndergraduate Classes, D.P. Khandelwal,1985, VaniPub.

C-11(T)   PHYC-503
QUANTUMMECHANICSANDAPPLICATIONS
(Credits: Theory-03, Practicals-01)

Unit-1
TimedependentSchrodingerequation:
TimedependentSchrodingerequationanddynamicalevolutionofaquantumstate;PropertiesofWaveFunction.InterpretationofWaveFunctionProbability and probability current densities inthreedimensions;Normalization.Eigenvalues and Eigenfunctions. Position, momentum, andEnergy operators; commutator of position and momentum operators; Expectation values of positionandmomentum.WaveFunctionofaFreeParticle.

(5Lectures)

TimeindependentSchrodingerequation
Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as alinear combination of energy eigenfunctions; General solution of the time dependent Schrodingerequationintermsoflinearcombinationsofstationarystates; Application to spread of Gaussianwave-packet for a free particle in one dimension.

(6Lectures)

Unit-2
Generaldiscussion ofbound states inanarbitrarypotential
Continuityofwavefunction,applicationtoone-dimensionalproblem-squarewellpotential;Quantummechanicsofsimpleharmonicoscillator - energy levels and energy eigen functions using Frobenius method; Hermitepolynomials;groundstate.

(8Lectures)

Unit-3
Quantumtheoryofhydrogen-likeatoms:
Time independent Schrodinger equation in spherical polar coordinates; separation of variables forsecond order partial differential equation; angular momentum operator & quantum numbers; Radialwavefunctions from Frobenius method; shapes of the probability densities for ground & first excitedstates;Orbitalangularmomentumquantumnumberslandm;s,p,d,..shells.

(8Lectures)

Unit-4
AtomsinElectric&MagneticFields:
Electronangularmomentum.Spacequantization.ElectronSpinandSpinAngularMomentum.Larmor'sTheorem.Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: ElectronMagneticMomentandMagneticEnergy,GyromagneticRatioandBohrMagneton.

(7Lectures)

AtomsinExternalMagneticFields:
NormalandAnomalousZeemanEffect.PaschenBackandStarkEffect(QualitativeDiscussiononly).

(3Lectures)

Unit-5

Manyelectronatoms:

Pauli'sExclusionPrinciple.Symmetric&AntisymmetricWaveFunctions.Periodictable.Finestructure.Spin orbitcoupling.Totalangularmomentum.Vector Model. Spin-orbit coupling in atoms - L-S and J-J couplings. Hund's Rule. Term symbols.SpectraofHydrogenandAlkaliAtoms(Naetc.).

(8Lectures)

ReferenceBooks:

- ATextbookofQuantumMechanics,P.M. MathewsandK.Venkatesan,2ndEd.,2010,McGrawHill
- QuantumMechanics,RobertEisbergandRobertResnick,2ndEdn.,2002,Wiley.
- QuantumMechanics,LeonardI.Schiff,3rdEdn.2010,TataMcGrawHill.
- QuantumMechanics,G.Aruldhas,2ndEdn.2002,PHILearningofIndia.
- QuantumMechanics,BruceCameronReed,2008,JonesandBartlettLearning.
- QuantumMechanics:Foundations&Applications,ArnoBohm,3rdEdn.,1993,Springer
- Quantum Mechanics forScientists& Engineers, D.A.B. Miller, 2008,Cambridge UniversityPress
- Quantum Mechanics, JohnL. Powell andBerndCrasemann, Addison-Wesley PublishingCompany

AdditionalBooksforReference

- QuantumMechanics,EugenMerzbacher,2004,JohnWileyandSons,Inc.
- IntroductiontoQuantumMechanics,D.J.Griffith,2ndEd.2005,PearsonEducation
- QuantumMechanics,WalterGreiner,4thEdn.,2001,Springer

- -

PHYSICSLAB

C-11(P)   PHYC-503

QUANTUMMECHANICSAND APPLICATIONS

Use C/C^{++}/Scilab for solving the following problems based on Quantum Mechanics like

1.) Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogenatom:

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

Here, *m* is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is $\approx$ -13.6 eV. Take e = 3.795 (eVÅ)$^{1/2}$, $\hbar c$ = 1973 (eVÅ) and m = 0.511 × 10^{6}eV/c^2.

2.) Solve the s-wave radial Schrodinger 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 mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r} e^{\frac{-r}{a}}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 (eVÅ)$^{1/2}$, m = 0.511 × 10^6 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units $\hbar c$ = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3.) Solve the s-wave radial Schrodinger equation for a particle of mass*m*:

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

For the anharmonic oscillatorpotential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3} In these units, c$\hbar$ = 197.3 MeV fm. The ground state energy is expected to lie between 90 and 110 MeV for all threecases.

4.) Solve the s-wave radial Schrodinger equation for the vibrations of hydrogenmolecule:

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

where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D(e^{-2\alpha r'} - e^{-\alpha r'}), \qquad r' = \frac{r - r_0}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.
Take m = 940 × 10^{6}eV /C^2, D = 0.755501 eV, α = 1.44, r_0 = 0.131349 Å

Laboratory based experiments:

1. Study of Electron spin resonance - determine magnetic field as a function of the resonance frequency
2. Study of Zeeman effect: with external magnetic field; Hyperfinesplitting
3. To show the tunneling effect in tunnel diode using I-Vcharacteristics.
4. Quantum efficiency ofCCDs

Reference Books:

- Schaum's Outline of Programming with C++. J.Hubbard, 2000,McGraw-HillPublication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rdEdn., 2007, Cambridge UniversityPress.
- An Introduction to Computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ.Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & EngineeringApplications:A.VandeWouwer,P.Saucez,C.V.Fernández.2014Springer.
- Scilab(AFreeSoftwaretoMatlab):H.Ramchandran,A.S.Nair.2011S.Chand&Co.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rdEdn., Cambridge UniversityPress
- Scilab Image Processing: L.M.Surhone.2010 Betascript PublishingISBN:978-6133459274

Semester VI

C-12(T)   PHYC-601STATISTICALMECHANICS

(Credits: Theory-03, Practicals-01)

Unit-1
ClassicalStatistics:

Macrostate&Microstate,ElementaryConceptofEnsemble,PhaseSpace,EntropyandThermodynamicProbability,Maxwell-BoltzmannDistributionLaw,PartitionFunction,Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox,LawofEquipartitionofEnergy(withproof)–ApplicationstoSpecificHeatanditsLimitations,ThermodynamicFunctionsofaTwo-EnergyLevelsSystem.

(12Lectures)

Unit-2
ClassicalTheoryofRadiation:

Properties of ThermalRadiation.Blackbody Radiation. Kirchhoff'slaw. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law.Wien'sDistributionLaw.Saha'sIonizationFormula.Rayleigh-Jean'sLaw.UltravioletCatastrophe.

(8 Lectures)

Unit-3
QuantumTheoryofRadiation:

SpectralDistributionofBlackBodyRadiation.Planck'sQuantumPostulates.Planck'sLawofBlackbodyRadiation:ExperimentalVerification.Deductionof(1) Wien's Distribution Law, (2)Rayleigh-JeansLaw,(3)Stefan-BoltzmannLaw,(4)Wien'sDisplacementlawfromPlanck'slaw.

(5Lectures)

Unit-4
Bose-EinsteinStatistics:

B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einsteincondensation,propertiesofliquidHe(qualitativedescription),RadiationasaphotongasandThermodynamicfunctionsofphotongas.BosederivationofPlanck'slaw.

(10Lectures)

Unit-5
Fermi-DiracStatistics:

Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly DegenerateFermi Gas, Fermi Energy, Electrongas ina Metal, Specific Heatof Metals, Relativistic Fermigas,WhiteDwarfStars,ChandrasekharMassLimit.   **(10Lectures)**

ReferenceBooks:

- StatisticalMechanics,R.K.Pathria,ButterworthHeinemann:2ndEd.,1996,OxfordUniversityPress.
- StatisticalPhysics,BerkeleyPhysicsCourse,F.Reif,2008,TataMcGraw-Hill
- StatisticalandThermalPhysics,S.LokanathanandR.S.Gambhir.1991,PrenticeHall
- Thermodynamics,KineticTheoryandStatisticalThermodynamics,FrancisW.SearsandGerhardL.Salinger,1986,Narosa.
- ModernThermodynamicswithStatisticalMechanics,CarlS.Helrich,2009,Springer
- AnIntroductiontoStatisticalMechanics&Thermodynamics,R.H.Swendsen,2012,Oxford Univ.Press

PHYSICS LAB

C-12(P)   PHYC-601STATISTICALMECHANICS

Use C/C++/Scilab/other numerical simulations for solving the problems based on StatisticalMechanicslike

1. Computationalanalysisofthebehaviorofa collectionofparticlesina boxthat satisfyNewtonianmechanicsandinteract via the Lennard-Jones potential, varying the total numberofparticlesNandthe initial conditions:
    a. Studyoflocalnumberdensityintheequilibriumstate(i)average;(ii)fluctuations
    b. Studyoftransientbehaviorofthesystem(approachtoequilibrium)
    c. RelationshipoflargeNandthearrowoftime
    d. Computationofthevelocitydistributionofparticlesforthesystemandcomparisonwiththe Maxwellvelocitydistribution
    e. Computationandstudyofmeanmolecularspeedanditsdependenceonparticlemass
    f. Computationoffractionofmoleculesinanidealgashavingspeednearthemostprobablespeed

2. Computation of the partition function Z(β) for examples of systems with a finite number ofsingleparticlelevels(e.g.,2 level,3 level,etc.)and afinitenumberofnon-interactingparticlesNunderMaxwell-Boltzmann,Fermi-DiracandBose-Einsteinstatistics:
    a. StudyofhowZ(β),averageenergy<E>,energyfluctuationΔE,specificheatatconstantvolume Cv,dependuponthetemperature, total number of particles N andthespectrumofsingleparticlestates.
    b. Ratiosofoccupationnumbersofvariousstatesforthesystemsconsideredabove
    c. ComputationofphysicalquantitiesatlargeandsmalltemperatureTandcomparisonofvariousstatisticsatlargeandsmalltemperatureT.

3. Plot Planck's law for Black Body radiation and compare it with Rayleigh-Jeans Law at hightemperatureandlowtemperature.

4. PlotSpecificHeatofSolids(a)Dulong-Petitlaw,(b)Einsteindistributionfunction,
(c) Debye distributionfunction for high temperature and low temperature and compare themfor thesetwocases.

5. Plotthefollowingfunctionswithenergyatdifferenttemperatures
    a. Maxwell-Boltzmanndistribution
    b. Fermi-Diracdistribution
    c. Bose-Einsteindistribution

ReferenceBooks:

- ElementaryNumericalAnalysis,K.E.Atkinson,3rdEdn.2007,WileyIndiaEdition
- StatisticalMechanics,R.K.Pathria,ButterworthHeinemann:2ndEd.,1996,OxfordUniversityPress.
- IntroductiontoModernStatisticalMechanics,D.Chandler,OxfordUniversityPress,1987
- Thermodynamics,KineticTheoryandStatisticalThermodynamics,FrancisW.SearsandGerhardL.Salinger,1986,Narosa.
- ModernThermodynamicswithStatisticalMechanics,CarlS.Helrich,2009,Springer
- StatisticalandThermalPhysicswithComputerApplications,HarveyGouldandJanTobochnik,PrincetonUniversityPress,2010.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: ScientificandEngineeringApplications:A.VandeWouwer, P. Saucez, C. V. Fernández. 2014SpringerISBN:978-3319067896Scilabbyexample:M.Affouf,2012.ISBN:978-1479203444
- ScilabImageProcessing:L.M.Surhone.2010,BetascriptPub.,ISBN:978-6133459274

C-13(T)   PHYC-602
ELECTROMAGNETICTHEORY

(Credits: Theory-03, Practicals-01)

Unit-1
Maxwell'sEquations:
ReviewofMaxwell'sequations.DisplacementCurrent.VectorandScalarPotentials.BoundaryConditionsatt heinterfacebetweenDifferentMedia.WaveEquations.PlaneWavesinDielectricMedia.PoyntingTheorema ndPoynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic FieldEnergyDensity,MomentumDensityandAngularMomentumDensity.

(9Lectures)

Unit-2
EMWavePropagationinUnboundedMedia:
Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EMwaves, refractive index and dielectric constant, wave impedance. Propagation through conductingmedia,relaxationtime,skin depth.Wavepropagation through dilute plasma, electrical conductivityofionized gases, plasmafrequency,refractiveindex, skin depth.

(8Lectures)

Unit-3
EMWaveinBoundedMedia:
Boundaryconditionsataplaneinterfacebetweentwomedia.Reflection&Refraction   of planewavesataplaneinterfacebetweentwodielectricmedia-
LawsofReflection&Refraction.Fresnel'sFormulaeforperpendicular&parallel   polarization   cases, Brewster's law. Reflection &Transmission coefficients. Total internal reflection, evanescent waves.

(**8Lectures**)

Unit-4
PolarizationofElectromagneticWaves:
DescriptionofLinear,CircularandEllipticalPolarization.PropagationofE.M.WavesinAnisotropicMedia.U niaxialandBiaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by DoubleRefraction.NicolPrism.Ordinary&extraordinaryrefractiveindices.   Production   &   detection ofPlane,CircularlyandEllipticallyPolarizedLight.PhaseRetardationPlates:Quarter-WaveandHalf-WavePlates.

(9 Lectures)

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theoryof optical rotation. Specificrotation.Laurent'shalf-shadepolarimeter.

(3Lectures)

Unit-5

Wave Guides: Planar optical waveguides. Planar dielectric waveguide. Condition of continuity atinterface. Phase shift on total reflection. Phase and group velocity of guidedwaves.FieldenergyandPowertransmission.

(5Lectures)

Optical Fibres: Numerical Aperture. Step and Graded Indices (Definitions Only). Single andMultipleModeFibres(ConceptandDefinitionOnly).

(3Lectures)

ReferenceBooks:

- IntroductiontoElectrodynamics,D.J.Griffiths,3rdEd.,1998,BenjaminCummings.
- ElementsofElectromagnetics,M.N.O.Sadiku,2001,OxfordUniversityPress.
- IntroductiontoElectromagneticTheory,T.L.Chow,2006,Jones&BartlettLearning
- FundamentalsofElectromagnetics,M.A.W.Miah,1982,TataMcGrawHill
- ElectromagneticFieldTheory,R.S.Kshetrimayun,2012,CengageLearning
- EngineeringElectromagnetic,WillianH.Hayt,8thEdition,2012,McGrawHill.
- ElectromagneticFieldTheoryforEngineers&Physicists,G.Lehner,2010,Springer

AdditionalBooksforReference

- ElectromagneticFields&Waves,P.Lorrain&D.Corson,1970,W.H.Freeman&Co.
- Electromagnetics,J.A.Edminster,SchaumSeries,2006,TataMcGrawHill.
- ElectromagneticFieldTheoryFundamentals,B.GuruandH.Hiziroglu,2004,CambridgeUniversityPress

----

PHYSICS LAB

C-13(P)   PHYC-602

ELECTROMAGNETICTHEORY

1. ToverifythelawofMalusforplanepolarizedlight.
2. TodeterminethespecificrotationofsugarsolutionusingPolarimeter.
3. Toanalyzeellipticallypolarizedlightbyusingabinet'scompensator.
4. TostudydependenceofradiationonangleforasimpleDipoleantenna.
5. Todeterminethewavelengthandvelocityofultrasonicwavesinaliquid(KeroseneOil,Xylene,etc.)bystudyingthediffractionthroughultrasonicgrating.
6. Tostudythereflection,refractionofmicrowaves
7. TostudyPolarizationanddoubleslitinterferenceinmicrowaves.
8. TodeterminetherefractiveindexofliquidbytotalinternalreflectionusingWollaston'sair-film.
9. Todeterminetherefractiveindexof(1)glassand(2)aliquidbytotalinternalreflectionusingaGaussianeyepiece.
10. Tostudythepolarizationoflightbyreflectionanddeterminethepolarizingangleforair-glassinterface.
11. ToverifytheStefan'slawofradiationandtodetermineStefan'sconstant.
12. TodeterminetheBoltzmannconstantusingV-IcharacteristicsofPNjunctiondiode.

ReferenceBooks:

● AdvancedPracticalPhysicsforStudents,B.L.FlintandH.T.Worsnop,1971,AsiaPublishingHouse.
● Advanced LevelPhysics Practicals, Michael Nelson and Jon M.Ogborn,4th Edition,reprinted1985,HeinemannEducationalPublishers
● ATextBookofPracticalPhysics,I.Prakash&Ramakrishna,11[th]Ed.,2011,KitabMahal
● ElectromagneticFieldTheoryforEngineers&Physicists,G.Lehner,2010,Springer

----

C-14(T)   PHYC-603

SOLIDSTATEPHYSICS

(Credits: Theory-03, Practicals-01)

Unit-1
CrystalStructure:
Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices.BrillouinZones.DiffractionofX-raysbyCrystals.Bragg'sLaw.

(8Lectures)

Unit-2
ElementaryLatticeDynamics:
LatticeVibrationsandPhonons:LinearMonoatomicandDiatomicChains.AcousticalandOpticalPhonons. Qualitative description of the Phonon Spectrum in Solids. Dulong and Petit's Law,Einstein,andDebyetheoriesofspecificheatofsolids.T^3law

(8Lectures)

Unit-3
MagneticProperties of Matter:
Dia, Para, Ferri and Ferromagnetic Materials. Classical Langevin Theory of Dia and ParamagneticDomains.QuantumMechanicalTreatmentofParamagnetism.Curie'slaw,Weiss'sTheoryofFerromagnetismandFerromagneticDomains.DiscussionofB-HCurve.HysteresisandEnergyLoss.

(8Lectures)

Unit-4
DielectricPropertiesofMaterials:
Polarization.LocalElectricFieldatanAtom.DepolarizationField.ElectricSusceptibility.Polarizability.
Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal andAnomalousDispersion.Langevin-
Debyeequation.ComplexDielectricConstant.OpticalPhenomena.Application:PlasmaOscillations,PlasmaFrequency,Plasmons.

(7Lectures)

FerroelectricPropertiesofMaterials:
Structuralphasetransition,Classificationofcrystals,Piezoelectriceffect,Pyroelectriceffect,Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law.

(3lectures)

Unit-5
Elementarybandtheory:
KronigPennyModel.BandGap.Conductor,Semiconductor(PandNtype)andinsulator.ConductivityofSemiconductor,mobility,HallEffect.Measurementofconductivity(04probemethod)andHallcoefficient.

(7Lectures)

Superconductivity:
ExperimentalResults.CriticalTemperature.Criticalmagneticfield. Meissner effect. Type I andTypeII Superconductors, London's Equation and PenetrationDepth. Idea of BCStheory(Noderivation)

(4Lectures)

ReferenceBooks:

IntroductiontoSolidStatePhysics,CharlesKittel,8[th]Edition,2004,WileyIndiaPvt.Ltd.ElementsofSolidStatePhysics,J.P.Srivastava,4[th]Edition,2015,Prentice-HallofIndiaIntroductiontoSolids,LeonidV.Azaroff,2004,TataMc-GrawHill

SolidStatePhysics,N.W.AshcroftandN.D.Mermin,1976,CengageLearning

SolidStatePhysics,H.IbachandH.Luth,2009,SpringerSolidState

Physics,RitaJohn,2014,McGrawHill

ElementarySolidStatePhysics,1/eM.AliOmar,1999,PearsonIndiaSolidStatePhysics,M.A.Wahab,2011,NarosaPublications

PHYSICS LAB

C-14(P)   PHYC-603

SOLID STATE PHYSICS

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to $150^{o}C$) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

Reference Books:

- Advanced Practical Physics for Students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
- Advanced Level Physics Practicals, Michael Nelson and Jon M.Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Elements of Solid State Physics, J.P.Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

C-15(T)   PHYC-604(A)
EXPERIMENTALTECHNIQUES
(Credits:Theory-03,Practicals-01)

Unit1
Measurements:
Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Grosserror, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation frommean,averagedeviation,standarddeviation,chi-square).

(4Lectures)

SignalsandSystems:
Periodicandaperiodicsignals. Impulse response, transfer function and frequency response of firstandsecondordersystems.FluctuationsandNoiseinmeasurementsystem.   S/N   ratio   and Noisefigure.Noiseinfrequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shotnoise,1/f noise.

(6Lectures)

Unit2
ShieldingandGrounding:
Methodsofsafetygrounding.Energycoupling.Grounding.Shielding:Electrostaticshielding.ElectromagneticInterference.

(3 Lectures)

Transducers&IndustrialInstrumentation(workingprinciple,efficiency,applications):
Staticanddynamiccharacteristicsofmeasurement Systems.Generalizedperformance
ofsystems,Zeroorder,firstorder,secondorderandhigherordersystems.
Electrical,ThermalandMechanicalsystems.Calibration.Transducersandsensors.CharacteristicsofTransducers.

(6Lectures)

Unit3
Temperaturetransducers:RTD,Thermistor,Thermocouples,Semiconductortypetemperaturesensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge,Piezoelectric.RadiationSensors:PrincipleofGasfilleddetector,Ionizationchamber,Scintillation detector.

(10Lectures)

Unit4
DigitalMultimeter:
Comparisonofanaloganddigitalinstruments.Blockdiagram of digital
multimeter,principleofmeasurementofI,V,C.Accuracyandresolutionofmeasurement.

(4Lectures)

ImpedanceBridgesandQ-meter:
BlockdiagramandworkingprinciplesofRLCbridge.Q-meteranditsworkingoperation.DigitalLCRbridge.

(3Lectures)

Unit5
VacuumSystems:
Characteristicsofvacuum:Gaslaw,Meanfreepath.Applicationof vacuum. Vacuum system -Chamber, Mechanical   pumps,   Diffusion   pump   &   Turbo   Modular   pump,   Pumping   speed, Pressuregauges(Pirani,Penning,ionization).

(9Lectures)

ReferenceBooks:

- Measurement,InstrumentationandExperimentDesigninPhysicsandEngineering,M.SayerandA.Mansingh,PHILearningPvt.Ltd.
- ExperimentalMethodsforEngineers,J.P.Holman,McGrawHill
- IntroductiontoMeasurementsandInstrumentation,A.K.Ghosh,3rdEdition,PHILearningPvt.Ltd.
- TransducersandInstrumentation,D.V.S.Murty,2ndEdition,PHILearningPvt.Ltd.
- InstrumentationDevicesandSystems,C.S.Rangan,G.R.Sarma,V.S.V.Mani,TataMcGrawHill
- PrinciplesofElectronicInstrumentation,D.Patranabis,PHILearningPvt.Ltd.
- ElectronicCircuits:HandbookofDesign&Applications,U.Tietze,Ch.Schenk,Springer

----

PHYSICS LAB

C-15(P) PHYC-604(A)

EXPERIMENTALTECHNIQUES

1. DetermineoutputcharacteristicsofanLVDTandmeasuredisplacementusingLVDT
2. MeasurementofStrainusingStrainGauge.
3. Measurementoflevelusingcapacitivetransducer.
4. TostudythecharacteristicsofaThermostatanddetermineitsparameters.
5. Studyofdistancemeasurementusingultrasonictransducer.
6. CalibrateSemiconductortypetemperaturesensor(AD590,LM35orLM75)
7. TomeasurethechangeintemperatureofambientusingResistanceTemperatureDevice(RTD).
8. Create vacuum in a small chamber using a mechanical (rotary) pump and measure thechamberpressureusingapressuregauge.
9. Comparison of pickup of noise in cables of different types (co-axial, single shielded, doubleshielded,withoutshielding)of2mlength,understandingof the importance of groundingusingfunctiongeneratorofmVlevelandanoscilloscope.
10. TodesignandstudytheSampleandHoldCircuit.
11. DesignandanalyzetheClippersandClamperscircuitsusingjunctiondiode
12. Toplotthefrequencyresponseofamicrophone.
13. TomeasureQofacoilandinfluenceoffrequency,usingaQ-meter.

ReferenceBooks:

ElectronicCircuits:HandbookofDesignandApplications,U.TietzeandC.Schenk,2008,Springer
BasicElectronics:ATextLabManual,P.B.Zbar,A.P.Malvino,M.A.Miller,1990,Mc-GrawHill
Measurement,InstrumentationandExperimentDesigninPhysics&Engineering,M.SayerandA.Mansingh,2005,PHILearning.

C-15(T)   PHYC-604(B)
PHYSICSOFDEVICESANDCOMMUNICATIONSYSTEMS

(Credits:Theory-03,Practicals-01)

Unit-1
Devices:
Characteristic and small signal equivalent circuits of UJT and JFET. Metal-semiconductor Junction.Metal oxide semiconductor (MOS) device. SiO_2-Si based MOS.MOSFET –their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Chargecoupleddevices.Tunneldiode.

(9Lectures)

Unit-2
Multivibrators:
AstableandMonostableMultivibratorsusingtransistors.

(2Lectures)

PhaseLockedLoop(PLL):
BasicPrinciples,Phasedetector (XOR & edge triggered), Voltage Controlled Oscillator (Basics,varactor).LoopFilter–Function, Loop Filter Circuits, transient response, lock and capture. Basicideaof PLLIC(565or4046).

(5Lectures)

Unit-3
Processing ofDevices:
BasicprocessflowforICfabrication,electronicgradesilicon.Crystalplaneandorientation.Defectsinthelattice.Oxidelayer.OxidationTechniqueforSi.Metallizationtechnique.PositiveandNegativeMasks.Opticallithography.Electronlithography.Featuresizecontrolandwetanisotropicetching.Diffusionandimplantation.

(10Lectures)

Unit-4
DigitalDataCommunication Standards:
SerialCommunications:RS232,Handshaking,Implementation of RS232 on PC. UniversalSerialBus (USB): USBstandards, Types and elements of USB transfers. Devices (Basic idea of UART).ParallelCommunications:GeneralPurposeInterfaceBus(GPIB),GPIBsignalsandlines,Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sendingdatathroughaCOMport.

(5Lectures)

PowersupplyandFilters:
Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and loadregulation, short circuit protection, Active and Passive Filters, Low Pass, High Pass, Band Pass andbandReject Filters.

(4Lectures)

Unit-5
IntroductiontoCommunicationSystems:
Block diagram of electronic communication system, Need for modulation. Amplitude modulation.Modulation Index. Sideband frequencies in AM wave. CEAmplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency,Phase,PulseandDigitalModulationincludingASK,PSK, FSK.

(10lectures)

ReferenceBooks:

PhysicsofSemiconductorDevices,S.M.Sze&K.K.Ng,3rdEd.2008,JohnWiley&SonsElectronicDevicesandIntegratedCircuits,A.K.Singh,2011,PHILearningPvt.Ltd.

Op-Amps and Linear Integrated Circuits, R.A.Gayakwad,4Ed. 2000,PHILearningPvt. LtdElectronicDevicesandCircuits,A.Mottershead,1998,PHILearningPvt.Ltd.

ElectronicCommunicationSystems,G.Kennedy,1999,TataMcGrawHill.

IntroductiontoMeasurementsandInstrumentation,A.K.Ghosh,3rdEd.,2009,PHILearningPvt.Ltd.

SemiconductorPhysicsandDevices,D.A.Neamen,2011,4thEdition,McGrawHill

PCbasedinstrumentation;ConceptsandPractice,N.Mathivanan,2007,Prentice-HallofIndia

----

PHYSICS LAB

C-15(P)   PHYC-604(B)
PHYSICS OF DEVICES AND COMMUNICATION

Experiments from both Section A and Section B:

Section-A
1. To design a power supply using bridge rectifier and study effect of C-filter.
2. To design the active Low pass and High pass filters of given specification.
3. To design the active filter (wide band pass and band reject) of given specification.
4. To study the output and transfer characteristics of a JFET.
5. To design a common source JFET Amplifier and study its frequency response.
6. To study the output characteristics of a MOSFET
7. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
8. To design an Amplitude Modulator using Transistor.
9. To design PWM, PPM, PAM and Pulse code modulation using ICs.
10. To design an Astable multivibrator of given specifications using transistor.
11. To study a PLL IC (Lock and capture range).
12. To study envelope detector for demodulation of AM signal.
13. Study of ASK and FSK modulator.
14. Glow an LED via USB port of PC.
15. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

Section-B:
SPICE/MULTISIM simulations for electrical networks and electronic circuits
1. To verify the Thevenin and Norton Theorems.
2. Design and analyze the series and parallel LCR circuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain
4. Design and Verification of op-amp as integrator and differentiator
5. Design the 1st order active low pass and high pass filters of given cutoff frequency
6. Design a Wein Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flops using NAND Gates
8. Design 4-bit asynchronous counter using Flip-Flop ICs
9. Design the CE amplifier of a given gain and its frequency response.
10. Design an Astable multivibrator using IC 555 of given duty cycle.

Reference Books:
Basic Electronics: A Text Lab Manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1994, Mc-GrawHill

Integrated Electronics, J.Millman and C.C.Halkias, 1991, Tata Mc-GrawHill. Electronics: Fundamentals and Applications, J.D.Ryder, 2004, Prentice Hall.

OP-Amps and Linear Integrated Circuit, R.A.Gayakwad, 4th edn., 2000, Prentice Hall. Introduction to PSPICE using ORCAD for circuits & Electronics, M.H.Rashid, 2003, PHI Learning.

PC Based Instrumentation; Concepts and Practice, N.Mathivanan, 2007, Prentice-Hall of India

- -

Semester VII

C-16(T)   PHYC-701(A)

NUCLEARANDPARTICLEPHYSICS

(Credits: Theory-03, Tutorials-02)

Unit-1
GeneralPropertiesofNuclei:
Constituentsofnucleusand their intrinsic properties, quantitative facts about mass, radii, chargedensity(matterdensity),bindingenergy,averagebindingenergyanditsvariationwithmassnumber,angularmomentum,parity,magneticmoment,electricmoments,nuclearexcitedstates.

(7Lectures)

Particlephysics:
Particle interactions; basic features, types of particles and its families. Symmetries and ConservationLaws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin,conceptofquarkmodel.

(5Lectures)

Unit-2
NuclearModels:
Liquiddropmodel approach, semi empirical mass formula and significance of its various terms,conditionofnuclearstability,evidence   for   nuclear   shell   structure, nuclearmagicnumbers,basicassumptionofshellmodel,conceptofmeanfield,residualinteraction,conceptof nuclearforce.

(7Lectures)

Unit-3
Radioactivitydecay:
(a) Alpha decay: basics of a-decay processes, theory of a-emission, Gamow factor, Geiger Nuttalllaw. (b) beta-decay: energy kinematics for beta-decay, positron emission,electron capture, neutrino hypothesis. (c) Gamma decay: Gamma ray emission and kinematics,internalconversion.

(7Lectures)

Unit-4
NuclearReactions:
TypesofReactions,Conservation Laws, kinematics of reactions, Q-value, reaction rate, reactioncross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering(Rutherfordscattering).

(5Lectures)

InteractionofNuclearRadiationwithmatter:
Energy loss due to ionization (Bethe-Block formula), Cerenkov radiation.Gamma ray interaction through matter, photoelectric effect, Compton scattering,pair production,neutroninteraction withmatter.

(5 Lectures)

Unit-5

DetectorsforNuclearRadiations:

Gas detectors: estimation of electric field, mobility of particle, ionization chamber and GM Counter.BasicprincipleofScintillationDetectorsandconstructionofphoto-

multipliertube(PMT).Semiconductor Detectors (Si and Ge) for charge particle and photon detection(concept ofchargecarrierandmobility),neutrondetector.

(6Lectures)

ParticleAccelerators:

Acceleratorfacilities available in India: Van-de GraaffGenerator(Tandem accelerator), Linearaccelerator,Cyclotron, Synchrotrons.

(3Lectures)

ReferenceBooks:

IntroductoryNuclearPhysics,KennethS.Krane(WileyIndiaPvt.Ltd.,2008).Conceptsof NuclearPhysics,BernardL.Cohen.(TataMcgrawHill,1998).

IntroductiontothePhysicsofNucleiandParticles,R.A.Dunlap.(ThomsonAsia,2004).Introductionto HighEnergyPhysics,D.H.Perkins,CambridgeUniv.Press

IntroductiontoElementaryParticles,D.Griffith,JohnWiley&SonsQuarksandLe ptons,F.HalzenandA.D.Martin,WileyIndia,NewDelhi

BasicIdeasandConceptsinNuclearPhysics-AnIntroductoryApproach,K.Heyde(IOP-Institute ofPhysicsPublishing,2004).

RadiationDetectionandMeasurement,G.F.Knoll(JohnWiley&Sons,2000).

PhysicsandEngineeringofRadiationDetection,SyedNaeemAhmed(AcademicPress,Elsevier,200 7).

TheoreticalNuclearPhysics,J.M.BlattandV.F.Weisskopf(DoverPub.Inc.,1991)

- -

C-16(T) PHYC-701(B)

CLASSICALDYNAMICS

(Credits:Theory-03,Tutorials-02)

Theemphasisofthecourseisonapplicationsinsolvingproblemsofinteresttophysicists.Studentsaretobeexamin edonthebasisofproblems,seenandunseen.

Unit-1
ClassicalMechanicsofPointParticles1:
ReviewofNewtonianMechanics;Applicationtothemotionofachargedparticleinexternalelectricandmagnet icfields-motioninuniformelectricfield,magneticfield-gyroradiusandgyrofrequency,Hamilton'sprinciple,LagrangianandtheEuler-Lagrangeequations,one-dimensionalexamplesoftheEuler-Lagrangeequations-one-dimensionalSimple Harmonic Oscillations andfallingbodyinuniformgravity.

(8Lectures)

Unit-2
ClassicalMechanicsofPointParticles2:
CanonicalmomentaandHamiltonian.Hamilton'sequationsofmotion.
Applications:Hamiltonianforaharmonicoscillator, solution of Hamilton's equation for SimpleHarmonicOscillations;particlein a central force field - conservation of angular momentum andenergy.

(8Lectures)

Unit-3
SmallAmplitudeOscillations:
Minimaofpotentialenergyandpointsofstableequilibrium,expansionofthepotentialenergyaround a minimum, small amplitude oscillations about the minimum, normal modes of oscillations,exampleofNidenticalmassesconnectedinalinearfashionto(N-1)identicalsprings.

(8Lectures)

Unit-4
SpecialTheoryofRelativity:
PostulatesofSpecialTheoryofRelativity.LorentzTransformations.Minkowskispace.Theinvariantinterval, lightconeandworldlines.Space-timediagrams.Time-dilation,lengthcontraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity andacceleration.Metricandalternatingtensors.Four-momentumandenergy-momentumrelation.Dopplereffectfromafour-vectorperspective.Conceptoffour-force.Relativistickinematics.

(13Lectures)

Unit-5
FluidDynamics:
Density and pressure P in a fluid, an element of fluid and its velocity, continuity equation and massconservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through apipe,Navier-Stokesequation,qualitativedescriptionofturbulence,Reynoldsnumber.

(8Lectures)

ReferenceBooks:

ClassicalMechanics,H.Goldstein,C.P.Poole,J.L.Safko,3rdEdn.2002,PearsonEducation.Mechanics,L.D.LandauandE.M.Lifshitz,1976,Pergamon.

ClassicalElectrodynamics,J.D.Jackson,3rdEdn.,1998,Wiley.

TheClassicalTheoryofFields,L.DLandau,E.MLifshitz,4thEdn.,2003,Elsevier.IntroductiontoElectrodynamics,D.J.Griffiths,2012,PearsonEducation.

ClassicalMechanics,P.S.Joag,N.C.Rana,1stEdn.,McGrawHall.

ClassicalMechanics,R.DouglasGregory,2015,CambridgeUniversityPress.Classical Mechanics:AnIntroduction,DieterStrauch,2009,Springer.

SolvedProblemsinClassicalMechanics,O.L.DelangeandJ.Pierrus,2010,OxfordPress

---

C-17(T)   PHYC-702(A)

ASTRONOMYANDASTROPHYSICS

(Credits: Theory-03, Tutorials-02)

Unit-1
AstronomicalScales:
AstronomicalDistance,MassandTime,Scales,Brightness,RadiantFluxandLuminosity,Measurement of Astronomical Quantities, Astronomical Distances, Stellar Radii, Masses of Stars,StellarTemperature.

Basicconceptsofpositionalastronomy:
CelestialSphere,GeometryofaSphere,SphericalTriangle,AstronomicalCoordinateSystems,Geographical CoordinateSystems,HorizonSystem,EquatorialSystem,ConversionofCoordinates,MeasurementofTime, SiderealTime,ApparentSolarTime,MeanSolarTime,EquationofTime,Calendar.

(9 Lectures)

Unit-2
BasicParametersofStars
Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity,DistanceModulus;Determination of Temperature and Radius of astar;DeterminationofMassesfromBinaryorbits; Hertzsprung-RussellDiagram.

(5Lectures)

TheSun
SolarParameters,SolarPhotosphere,SolarAtmosphere,Chromosphere.Corona,SolarActivity.Helioseism ology.

TheSolarSystem:
FactsandFigures,OriginoftheSolarSystem:TheNebularModel,TidalForcesandPlanetaryRings.

(4Lectures)

Unit-3
AstronomicalTechniques:
BasicOpticalDefinitionsforAstronomy,Magnification,LightGatheringPower,ResolvingPowerand Diffraction Limit, Atmospheric Windows, Optical Telescopes; Types of Reflecting Telescopes,TelescopeMountings,SpaceTelescopes,DetectorsandTheirUsewithTelescopes,TypesofDete ctors.

Physicalprinciples
Gravitation in Astrophysics, Virial Theorem, Newton versus Einstein, Systems in ThermodynamicEquilibrium.

(8Lectures)

Unit-4

StellarSpectraandClassification Structure

AtomicSpectraRevisited,StellarSpectra,SpectralTypes.BlackBodyApproximation,HRDiagram,LuminosityClassification

(3Lectures)

TheMilkyWay

Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way, DifferentialRotationoftheGalaxyand OortConstant,RotationCurveoftheGalaxy and the Dark Matter, Stars and Star Clusters of the Milky Way.

(7Lectures)

Unit-5

Galaxies

GalaxyMorphology, Hubble'sClassificationof Galaxies,Elliptical Galaxies,The IntrinsicShapesofEllipticalStarsandGas. Spiral and Lenticular Galaxies, Bulges, Disks,GalacticHalo,TheMilkyWayGalaxy,GasandDustintheGalaxy,SpiralArms.

(4Lectures)

LargeScaleStructure&ExpandingUniverse:

CosmicDistanceLadder,DistanceMeasurementusingCepheidVariables,Hubble'sLaw,Distance-VelocityRelation,ClustersofGalaxies,VirialtheoremandDarkMatter.

(5Lectures)

ReferenceBooks:

Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition,SaundersCollegePublishing.

ThePhysicalUniverse:AnIntroductiontoAstronomy,F.Shu,MillValley:University ScienceBooks.

FundamentalofAstronomy(FourthEdition),H.Karttunenetal.Springer

Astrophysics A ModernPerspective, K.S.Krishnasamy, Reprint,New Age International(p)Ltd,NewDelhi,2002.

An Introduction toAstrophysics,BaidyanathBasu,Second printing, Prentice-Hall of IndiaPrivatelimited,NewDelhi,2001.

TextbookofAstronomyandAstrophysicswithElementsofCosmology,V.B.Bhatia,NarosaPublication.

C-17(T)   PHYC-702(B)

APPLIEDDYNAMICS

(Credits:Theory-03,Practicals-2)

Unit-1
IntroductiontoDynamicalsystems1
Definitionofacontinuousfirstorderdynamicalsystem.Theideaofphasespace,flowsandtrajectories. Simple mechanical systems as first order dynamical systems : the free particle, particleunder uniform gravity, simple and damped harmonic oscillator. Sketching flows and trajectories inphasespace;sketchingvariablesasfunctionsoftime,relatingtheequations and pictures to theunderlyingphysicalintuition.
Otherexamplesofdynamicalsystems–
InBiology:Populationmodelse.g.exponentialgrowthanddecay,logisticgrowth,predator-preydynamics,simplegeneticcircuits
InChemistry:Rateequationsforchemicalreactionse.g.autocatalysis,bistabilityInEconomics:Examples fromgametheory.

(9Lectures)

Unit-2
IntroductiontoDynamicalsystems2
Fixedpoints,attractors,stabilityoffixed points, basin of attraction, notion of qualitative analysis ofdynamicalsystems,withapplicationstotheaboveexamples.
Computingandvisualizingtrajectoriesonthecomputerusingsoftwarepackages.Discrete dynamicalsystems.Thelogisticmapasanexample.

(8Lectures)

Unit-3
IntroductiontoChaosandFractals1
Examples of 2-dimensional billiard,Projectionof thetrajectory on momentum space. Sinai Billiardand its variants. Computational visualization of trajectories in the Sinai Billiard. Randomization andergodicityinthedivergence of nearby phase space trajectories, and dependence of time scale ofdivergence on the size of obstacles. Electron motion in mesoscopic conductors as a chaotic billiardproblem.Otherexamplesofchaoticsystems;visualizationoftheirtrajectoriesonthecomputer.
Self similarity and fractal geometry: Fractals in nature – trees, coastlines, earthquakes, etc. Need forfractaldimensiontodescribeself-similarstructure.Deterministicfractalvs.self-similarfractalstructure.Fractalsindynamics –SerpinskigasketandDLA.

(9Lectures)

Unit-4
IntroductiontoChaosandFractals2
Chaosinnonlinearfinite-differenceequations-Logisticmap:Dynamicsfromtimeseries.Parameter dependence - steady, periodic and chaos states. Cobweb iteration. Fixed points. Definingchaos-aperiodic,bounded,deterministic and sensitive dependence on initial conditions.
Nonlinear time series analysis and chaos characterization: Detecting chaos from return map. Powerspectrum,autocorrelation,Lyapunovexponent,correlationdimension.

(9Lectures)

Unit-5

ElementaryFluidDynamics:

Importance of fluids: Fluids in the pure sciences, Fluids in technology. Study of fluids: Theoreticalapproach, experimental fluid dynamics, computational fluid dynamics. Basic physics of fluids: Thecontinuum hypothesis - concept of fluid element or fluid parcel; Definition of a fluid - shear stress;Fluidproperties-viscosity,thermalconductivity,massdiffusivity,Flow phenomena - flow dimensionality, steady and unsteady flows, uniform &non-uniform flows, viscous and inviscid flows, incompressible & compressible flows, laminar andturbulentflows,rotationalandirrotationalflows,separatedandunseparatedflows.

(10Lectures)

ReferenceBooks

- NonlinearDynamicsandChaos,S.H.Strogatz,LevantBooks,Kolkata,2007
- UnderstandingNonlinearDynamics,DanielKaplanandLeonGlass,Springer.
- AnIntroductiontoFluidDynamics,G.K.Batchelor,CambridgeUniv.Press,2002
- FluidMechanics,2ndEdition,L.D.LandauandE.M.Lifshitz,PergamonPress,Oxford,1987.

PHYSICS LAB

C-17(P)   PHYC-702(B)

APPLIEDDYNAMICS

Laboratory/ComputingandvisualizingtrajectoriesusingsoftwaresuchasScilab, Maple, Octave,XPPAUT basedonAppliedDynamicsproblemslike

1. Todeterminethecouplingcoefficientofcoupledpendulums.
2. Todeterminethecouplingcoefficientofcoupledoscillators.
3. Todeterminethecouplinganddampingcoefficientofdampedcoupledoscillator.
4. Tostudypopulationmodelse.g.exponentialgrowthand decay,logisticgrowth,speciescompetition,predator-preydynamics,simplegeneticcircuits.
5. Tostudyrateequationsforchemicalreactionse.g.autocatalysis,bistability.
6. Tostudyexamplesfromgametheory.
7. ComputationalvisualizationoftrajectoriesintheSinaiBilliard.
8. ComputationalvisualizationoftrajectoriesElectronmotioninmesoscopic conductorsas achaoticbilliardproblem.
9. ComputationalvisualizationoffractalformationsofDeterministicfractal.
10. Computationalvisualizationoffractalformationsofself-similarfractal.
11. ComputationalvisualizationoffractalformationsofFractalsinnature– trees,coastlines,earthquakes.
12. ComputationalFlowvisualization-streamlines,pathlines,Streamlines.

ReferenceBooks:

NonlinearDynamicsandChaos,StevenH.Strogatz,LevantBooks,Kolkata,2007UnderstandingNon linearDynamics,DanielKaplanandLeonGlass,Springer.
An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge Univ. Press, 2002FluidMechanics,2ndEdn,L.D.Landau&E.M.Lifshitz,PergamonPress,Oxford,1987
SimulationofODE/PDEModelswithMATLAB®,OCTAVEandSCILAB:Scientificand EngineeringApplications:A.VandeWouwer,P.Saucez,C.V.Fernández. 2014 SpringerISBN: 978-3319067896
ScilabbyExample,M.Affouf,2012,ISBN:978-1479203444
ScilabImageProcessing:L.M.Surhone.2010,BetascriptPub.,ISBN:978-6133459274

- -

PHYSICS–SEC-I
RENEWABLEENERGYANDENERGYHARVESTING

(Credits:03)

The aim of this course is not just to impart theoretical knowledge to the students but to provide themwithexposureandhands-onlearningwherevereverpossible

Unit-1
FossilfuelsandAlternateSourcesofEnergy:
Fossilfuelsandnuclearenergy,theirlimitations,needofrenewableenergy,non-conventionalenergysources.AnoverviewofdevelopmentsinOffshoreWindEnergy, TidalEnergy,Waveenergysystems,OceanThermalEnergyConversion,solarenergy,biomass,biochemical conversion,biogasgeneration,geothermalenergytidalenergy,Hydroelectricity.

(6Lectures)

Solarenergy: Solarenergy,itsimportance,storageofsolar energy, solar pond, non-convectivesolar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solardistillation,solarcooker,solargreenhouses,solarcell,absorptionairconditioning.Needandcharacterist ics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun trackingsystems.

(8Lectures)

Unit -2
WindEnergyharvesting
FundamentalsofWindenergy,WindTurbinesanddifferentelectricalmachinesinwindturbines,Powerelectro nicinterfaces,andgridinterconnectiontopologies.

(4Lectures)

GeothermalEnergy: GeothermalResources,GeothermalTechnologies.

(3Lectures)

Unit-3
OceanEnergy
OceanEnergyPotentialagainstWindandSolar,WaveCharacteristicsandStatistics,WaveEnergyDevices.

(4Lectures)

TidecharacteristicsandStatistics,TideEnergyTechnologies,OceanThermalEnergy,OsmoticPower,Ocean Bio-mass.

(3Lectures)

Unit-4
HydroEnergy
Hydropowerresources,hydropowertechnologies,environmentalimpactofhydropowersources.

(3Lectures)

PiezoelectricEnergyharvesting: Introduction,Physics and characteristics of piezoelectric effect,materials and mathematical description of piezoelectricity, Piezoelectric parameters and modelingpiezoelectricgenerators,Piezoelectricenergyharvestingapplications,Humanpower.

(6Lectures)

Unit-5
ElectromagneticEnergyHarvesting

Lineargenerators,physicsmathematicalmodels,recentapplicationsCarbon

(3Lectures)

capturedtechnologies,cell,batteries,powerconsumptionEnvironmentaliss

(3Lectures)

uesandRenewablesourcesofenergy,sustainability.

(2Lectures)

DemonstrationsandExperiments
1. DemonstrationofTrainingmodulesonSolarenergy,windenergy,etc.
2. Conversionofvibrationtovoltageusingpiezoelectricmaterials
3. Conversionofthermalenergyintovoltageusingthermoelectricmodules.

Reference Books:
- Non-conventionalEnergySources,G.DRai,KhannaPublishers,NewDelhi
- SolarEnergy,MPAgarwal,SChandandCo.Ltd.
- SolarEnergy,SuhasPSukhative,TataMcGraw-HillPublishingCompanyLtd.
- RenewableEnergy,PowerforaSustainableFuture,GodfreyBoyle,2004,OxfordUniversityPress,inassociationwithTheOpenUniversity.
- SolarEnergy:ResourceAssessmentHandbook,Dr.PJayakumar,2009
- Photovoltaics,J.Balfour,M.ShawandS.Jarosek,LawrenceJGoodrich(USA).
- http://en.wikipedia.org/wiki/Renewable_energy

PHYSICS – SEC-II

RADIATION SAFETY

(Credits:03)

The aim of this course is for awareness and understanding regarding radiation hazards and safety.The list of laboratoryskillsandexperiments listedbelow the course are to be done in continuationofthetopics

Unit-1
BasicsofAtomicandNuclearPhysics:
Basicconcept ofatomic structure; X rays characteristicandproduction; concept of bremsstrahlungandaugerelectron,Thecompositionofnucleusanditsproperties,massnumber,isotopesofelements,spin, bindingenergy,stableand unstable isotopes,law ofradioactivedecay, Meanlifeandhalf-life,basicconceptofalpha,betaandgammadecay,conceptofcrosssectionandkinematicsofnuclearreactions, typesofnuclearreaction,Fusion,fission.

(9Lectures)

Unit-2
InteractionofRadiationwithmatter:
TypesofRadiation:Alpha,Beta,GammaandNeutronandtheir sources,sealedandunsealedsources, InteractionofPhotons-Photo-electriceffect,ComptonScattering,PairProduction,LinearandMassAttenuationCoefficients,
Interaction of Charged Particles: Heavy charged particles - Beth-Bloch Formula, Scaling laws, MassStoppingPower,Range,Straggling,ChannelingandCherenkovradiation.BetaParticles-Collisionand Radiationloss(Bremsstrahlung),
InteractionofNeutrons-Collision,slowingdownandModeration.

(10Lectures)

Unit-3
Radiationdetectionandmonitoringdevices:
RadiationQuantitiesandUnits:Basicideaofdifferentunitsofactivity,KERMA,exposure,absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake(ALI) andderivedAirConcentration(DAC).
Radiationdetection:Basicconcept and working principle of gas detectors, Ionization Chambers,ProportionalCounter,Multi-WireProportionalCounters(MWPC)andGiegerMullerCounter,ScintillationDetectors(InorganicandOrganicScintillators),SolidStates Detectors and NeutronDetectors,Thermoluminescent Dosimetry.

(10Lectures)

Unit-4
Radiationsafetymanagement
Biologicaleffectsofionizingradiation,Operationallimitsandbasicsofradiationhazardsevaluationandcontrol:radiation protection standards, International Commission on RadiologicalProtection (ICRP) principles, justification, optimization, limitation, introduction of safety and riskmanagementofradiation.Nuclear waste and disposal management. Brief idea about AcceleratordrivenSub-criticalsystem(ADS)forwastemanagement.

(8Lectures)

Unit-5

Applicationofnucleartechniques:

Applicationinmedicalscience(e.g.,MRI,PET,ProjectionImagingGammaCamera,radiationtherapy),Archaeology,Art,Crimedetection, Mining and oil. Industrial Uses: Tracing, Gauging,MaterialModification,Sterilization,Foodpreservation.

(8Lectures)

Experiments:

1. StudythebackgroundradiationlevelsusingRadiationmeter CharacteristicsofGeigerMuller(GM)Counter:
2. StudyofcharacteristicsofGMtubeanddeterminationofoperatingvoltageandplateaulengthusingbackgroundradiationassource(withoutcommercialsource).
3. StudyofcountingstatisticsusingbackgroundradiationusingGMcounter.
4. Studyofradiationinvariousmaterials(e.g.KSO4etc.).InvestigationofpossibleradiationindifferentroutinematerialsbyoperatingGMatoperatingvoltage.
5. StudyofabsorptionofbetaparticlesinAluminumusingGMcounter.
6. Detectionofaparticlesusingreferencesourceanddeterminingitshalflifeusingsparkcounter
7. GammaspectrumofGasLightmantle(SourceofThorium)

ReferenceBooks

- NuclearandParticlePhysics,W.E.BurchamandM.Jobes,Longman(1995)
- RadiationDetectionandMeasurements,G.F.Knoll
- ThermoluninescenseDosimetry,Mcknlay,A.F.,Bristol,AdamHilger(MedicalPhysicsHandbook 5)
- FundamentalPhysicsofRadiology,W.J.MeredithandJ.B.Massey,JohnWrightandSons,UK,1989.
- FundamentalsofRadiationDosimetry,J.R.Greening,MedicalPhysicsHandBookSeries,No.6,AdamHilgerLtd.,Bristol1981.
- PracticalApplicationsofRadioactivityandNuclearRadiations,G.C.LowentalandP.L.Airey,CambridgeUniversityPress,U.K., 2001
- AnIntroductiontoRadiationProtection,A.MartinandS.A.Harbisor,JohnWilley&Sons,Inc.New York,1981.
- NCRP,ICRP,ICRU,IAEA,AERBPublications.
- MedicalRadiationPhysics,W.R.Hendee,YearBook,MedicalPublishersInc.London,1981

- -

PHYSICS – SEC-III
WEATHERFORECASTING

(Credits:03)

The aimof thiscourse is notjust to impart theoretical knowledge to the students but to enable themto develop an awareness and understanding regarding the causes and effects of different weatherphenomenonandbasicforecastingtechniques

Unit-1
Introductiontoatmosphere:
Elementary idea of atmosphere: physical structure and composition; compositional layering of theatmosphere;variationofpressureandtemperaturewithheight;airtemperature; requirements tomeasureairtemperature;temperaturesensors:types;atmosphericpressure:itsmeasurement;cyclonesandanticyclones:itscharacteristics.

(13Lectures)

Unit-2
Measuringtheweather:
Wind;forcesactingtoproducewind;windspeed direction: units, its direction; measuring windspeedand direction;humidity,clouds andrainfall, radiation:absorption, emissionand scattering intheatmosphere;radiationlaws.

(7Lectures)

Unit-3
Weathersystems:
Globalwindsystems;airmassesandfronts:classifications;jetstreams;localthunderstorms;tropicalcyclones:classification;tornadoes;hurricanes.

(7Lectures)

Unit-4
ClimateandClimateChange:
Climate:itsclassification;causesofclimatechange;globalwarminganditsoutcomes;airpollution;aerosols,ozonedepletion,acidrain,environmentalissuesrelatedtoclimate.

(7Lectures)

Unit-5
Basicsofweatherforecasting:
Weather forecasting: analysis and its historical background; need of measuring weather; types ofweatherforecasting;weatherforecastingmethods; criteria of choosing weather station; basics ofchoosingsiteandexposure;satellitesobservationsinweatherforecasting;weathermaps;uncertaintyandpredictability;probabilityforecasts.

(11Lectures)

Demonstrations and Experiments:

1. Study of synoptic charts and weather reports, working principle of weather station.
2. Processing and analysis of weather data:
   a. To calculate the sunniest time of the year.
   b. To study the variation of rainfall amount and intensity by wind direction.
   c. To observe the sunniest/driest day of the week.
   d. To examine the maximum and minimum temperature throughout the year.
   e. To evaluate the relative humidity of the day.
   f. To examine the rainfall amount monthwise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.
4. Formats and elements in different types of weather forecasts/warning (both aviation and non aviation)

Reference books:

- Aviation Meteorology, I.C.Joshi, 3rd edition 2014, Himalayan Books
- The Weather Observer's Hand Book, Stephen Burt, 2012, Cambridge University Press.
- Meteorology, S.R.Ghadekar, 2001, Agromet Publishers, Nagpur.
- Text Book of Agrometeorology, S.R.Ghadekar, 2005, Agromet Publishers, Nagpur.
- Why the Weather, Charles Franklin Brooks, 1924, Chapman & Hall, London.
- Atmosphere and Ocean, John G.Harvey, 1995, The Artemis Press.

- -