SRI VENKATESWARA UNIVERSITY:: TIRUPATI

DEPARTMENT OF PHYSICS

The Board of Studies in Physics (PG) Meeting held on 28-12-2021 Tuesday at 10.30 A.M. in the Chambers of the Head, Dept. of Physics, SVU College of Sciences, Tirupati, to discuss the following agenda:

AGENDA

Discussion on the NEP-2020 Syllabus of M.Sc. Physics and M.Sc. Instrumentation, to be implemented from the academic year 2021-2022.

Members Present

1. Prof. S. Vijaya Bhaskara Rao Department of Physics S.V.U. College of Sciences TIRUPATI.	:	Chairman (BOS in Physics (PG)
2. The Head Department of Physics S.V.U. College of Sciences TIRUPATI.	:	Member
3. Prof. Y.C. Ratnakaram Department of Physics S.V.U. College of Sciences TIRUPATI.	:	Member
4. Prof. B. Deva Prasad Raju Department of Physics S.V.U. College of Sciences TIRUPATI.	:	Member
5. Prof. R.P. Vijayalakshmi Department of Physics S.V.U. College of Sciences TIRUPATI	:	Member
6. Prof. K. Krishna Reddy Dept. of Physics Yogi Vemana University KADAPA.	:	External Member
7. Prof. DSVVD Prasad Dept. of Physics Andhra University VISAKHAPATNAM.	:	External member

RESOLUTION: The BOS has approved the NEP-2020 Syllabus of M.Sc. Physics and M.Sc. Instrumentation, to be implemented from the academic year 2021-2022 and to forward the same to the University.

1. 28/12/21
2. 28/12/21
3. 28.12.21
4. B. 28/12/2021
5. 28.12.21
6. 28/12/21
7. 28/12/2021

2021-2022

Programme Code	Programme name	Year of Introduction	Status of implementation of CBCS/Elective Course System (ECS)	Year of implementation of CBCS/ECS	Year of revision (ifany)	If revision has been carried out in the syllabus during the last 5 years, Percentage of Content added or replaced	Linktothe relevant documents
			CBCS: Yes/No ECS:Yes/No	CBCS: ECS:	CBCS: ECS:	CBCS: ECS:	CBCS: ECS:
242	M.Sc.Physics	1954	CBCS:YES ECS:YES	2009-2010	2021-2022	60	Enclosed (Syllabus)

SRI VENKATESWARA UNIVERSITY:: TIRUPATI

SVU COLLEGE OF SCIENCES

DEPARTMENT OF PHYSICS

Syllabus for M.Sc. PHYSICS

Choice Based Credit System (CBCS)

Amended as per NEP-2020

(w.e.f. the Academic Year 2021-2022)

Vision

To inculcate certain specific enabling skill sets to prepare the students to take up challenges in any one or more functional domains viz. (i) Academics; (ii) Basic and Applied Research; (iii) Research & Development; (iv) Engineering & Technology and (v) Industry.

Mission

To bring out professionals having knowledge of basic laws of nature together with strong fundamentals in the core area of physics viz. Classical Mechanics, Quantum Mechanics, Condensed Matter Physics, Electromagnetism, Computational Physics, Statistical Physics, Spectroscopy, Photonics, Thin film Technology and Solar Energy Physics, Electronics, Atomic and Nuclear Physics and advanced level topics such as High Energy Physics, Nanotechnology, Nonlinear Optics, etc.

PROGRAM EDUCATIONAL OBJECTIVES: At the end of the program, the student will be able to:

PEO1	Apply principles of basic scientific concepts in understanding, analysis, andpredictionof physical systems.
PEO2	Develophumanresourcewithspecializationintheoretical andexperimental Techniquesrequiredforcareerinacademic,researchandindustry.
PEO3	Engageinlifelonglearningandadapttochangingprofessionalandsocietalneeds.

PROGRAMOUTCOMES: At the end of the program, the student will be able to:

PO1	Applythe scientific knowledgetosolvethe complexphysicsproblems.
PO2	Identify,formulate,andanalyzeadvancedscientificproblemsreachingsubstantiated Conclusionsusingfirstprinciplesofmathematics,physical,andnaturalsciences.
PO3	Design solutions for advanced scientific problems and design system components orprocesses that meet the specified needs with appropriate attention to health and safetyrisks,applicablestandards,andeconomic,environmental,culturalandsocietal consideration.
PO4	Useresearch-basedknowledgeandmethodsincludingdesignofexperiments,analysisandinterpretation ofdata,andsynthesisoftheinformationtoprovidevalid conclusions.
PO5	Create,select,andapplyappropriatetechniques,resources,andmodernscientific Toolstocomplexphysicsproblemswithanunderstandingof thelimitations.
PO6	Applyreasoninginformedbythecontextualknowledgetoassesssocietal,health,safety,legalandculturalissues,andtheconsequentresponsibilitiesrelevanttothe Professionalscientificpractice.
PO7	Understandtheimpactofthescientificsolutionsinsocietalandenvironmental contexts,anddemonstratetheknowledgeof,andneed forsustainabledevelopment.
PO8	Applyethicalprinciplesandcommitto thenormsofscientificpractice.
PO9	Functioneffectivelyasanindividual,andasamemberorleaderindiverseteams, Andinmultidisciplinarysettings.

PO10	Communicateeffectivelyonscientificactivitieswiththe Scientific/Engineeringcommunity and with society at large, such as, being able to comprehend and writeeffectivereportsanddesigndocumentation,make effective representations,andgive Andreceiveclearinstructions.
PO11	Demonstrateknowledgeandunderstandingofthescientificprinciplesandapply Thesetoone'sownwork,asamember andleaderinateam,tomanageprojectsandinmultidisciplinaryenvironments.
PO12	Recognizetheneedfor,andhavethepreparationandabilitytoengageinindependent Andlife-longlearninginthebroadestcontext of scientific cand technologicalchange.

PROGRAMSPECIFICOUTCOMES: Attheend oftheprogram,thestudent willbeableto:

PSO1	Understandthebasicandadvanceconceptsofdifferentbranchesofphysics.
PSO2	Performanddesignexperimentsintheareasofelectronics,atomic,nuclear, Condensedmatter,andcomputationalphysics.
PSO3	Applythe conceptsof physicsinspecialized areasofcondensed, nuclear,renewable energies,particle physics,etc.in industry,academia, research anddaytodaylife.

SRIVENKATESWARAUNIVERSITY::TIRUPATI
DEPARTMENTOFPHYSICS
TWO YEAR M.Sc. COURSE IN PHYSICS (2021-2022) SCHEME

Semester -I

S.No	Components of Study	Title of theCourse	Titleof thePaper	Credit Hrs /Week	No. ofCredits	IA Marks	SemEndMarks	Total
1.	**Mandatory Core**	PHY101	1.ClassicalMechanicsandTheoryof Relativity	6	4	20	80	100
2.		PHY102	2.Solid State Physics	6	4	20	80	100
3.	**Compulsory Foundation**	PHY103(a)	1.Analogand DigitalElectronics	6	4	20	80	100
		PHY103(b)	2.Computational Methods &C Language					
		PHY103(c)	3.Sensorsand Transducers					
4.	**ElectiveFoundation**	PHY104(a)	1.Atomicand MolecularPhysics	6	4	20	80	100
		PHY104(b)	2.Optical,Microwaveand SatelliteCommunications					
		PHY104(c)	3.ComputerArchitectureand Networking					
5.	**Practical-I**	PHY105	Paper1&3 (GeneralLab)	6	4	--	100	100
6.	**Practical-II**	PHY106	Paper3 &4 (ElectronicsLab)	6	4	--	100	100
	Total			36	24	80	520	600
7.	AuditCourse			0	0	100	0	0

*Allcorepapers areMandatory

- CompulsoryFoundation chooseonepaper.
- ElectiveFoundation–Chooseonepaper.
- Auditcourse-100Marks (Internals)ZeroCreditsunderself-study.
- Interested students may register for MOOC with the approval of the concerned DDC butitwillbeconsideredfortheaward ofthe gradeasopen electiveonlygivingextracredits.

S.No	Components of Study	Title of theCourse	Titleof thePaper	Credit Hrs/ Week	No. ofCredits	IA Marks	SemEndMarks	Total
1.	**Mandatory Core**	PHY201	1. StatisticalMechanics	6	4	20	80	100
2.		PHY202	2.EM Theory,Lasers& Modern Optics	6	4	20	80	100
3.	**Compulsory Foundation**	PHY203(a)	1.NuclearPhysics	6	4	20	80	100
		PHY203(b)	2.ICfabrication Techniques					
		PHY203(c)	3.AdvancedMicroprocessors and itsApplications					
4.	**ElectiveFoundation**	PHY204(a)	1.Mathematical Physics	6	4	20	80	100
		PHY204(b)	2.Introductionto VLSIdesign					
		PHY204(c)	3.MaterialScience ForIndustrial Applications					
5.	**Practical-I**	PHY205	Paper1&3 (GeneralLab)	6	4	--	100	100
6.	**Practical-II**	PHY206	Paper3&4 (ElectronicsLab)	6	4	--	100	100
	Total			36	24	80	520	600
7.	AuditCourse			0	0	100	0	0

*Allcorepapers areMandatory

- CompulsoryFoundation chooseonepaper.
- ElectiveFoundation–Chooseonepaper.
- Auditcourse-100Marks (Internals)ZeroCreditsunderself-study.
- Interested students may register for MOOC with the approval of the concerned DDC butitwillbeconsideredfortheawardofthe grade asopenelectiveonlygiving extracredits.

S.No	Components of Study	Title of theCourse	Title of thePaper	Credit Hrs/ Week	No. ofCred its	IA Marks	Sem EndM arks	Total
1.	**Mandatory Core**	PHY301	1.Introductory QuantumM echanics	6	4	20	80	100
2.		PHY302	2.Physics ofSemiconduct or Devices	6	4	20	80	100
3.	**Generic Elective**	PHY303(a)	1.Applied Spectroscopy	6	4	20	80	100
		PHY303(b)	2.Condensed MatterPhysics					
		PHY303(c)	3.Embedded Systems					
4.	**Practicals**	PHY304	ElectiveLab	6	4	--	100	100
5.	**Skill Oriented Course**	PHY305	Advances inPhysics	6	4	10	90(T40 +P50)	100
6.	**Open Elective**	PHY306(a)	1.Basic Spectroscopic Techniques	6	4	20	80	100
		PHY306(b)	1. Nanomaterials andDevices					
	Total			36	24	90	510	600

*Allcorepapers areMandatory

- GenericElective– Choosetwo
- Corepapers andGenericElectives optedpaperheldPractical-I
- SkillOrientedCourseis Mandatory. Relevantsocietyalongwithpractical(10marksinternal40 final theory& 50 for practical's).
- OpenElectivesareforthestudentsof otherDepartments.Minimum onepapershouldbeopted. Extra credits may be earned by opting for more number of open electivesdependingon the interestof thestudent throughself-study.
- Interestedstudents mayregisterfor MOOC withthe approval oftheconcerned DDC.

S.No	Components ofstudy	Title of theCourse	Title of thePaper	Credit Hrs/ Week	No. ofCred its	IA Marks	Sem EndM arks	Total
1.	**Mandatory Core**	PHY401	1.Advanced QuantumM echanics	6	4	20	80	100
2.		PHY402	2.Physicsof Advanced Materials	6	4	20	80	100
3.	**Generic Elective**	PHY403(a)	1.Photonics	6	4	20	80	100
		PHY403(b)	2.SolarEnergy-Thermal andPhotovoltai c Properties					
		PHY403(c)	3.Vacuumand ThinFilm Technology					
4.	**Practicals**	PHY404	ElectiveLab	6	4	--	100	100
5.	**Multi Disciplinary Course/Proje ctWork**	PHY405	Advanced Characterization Techniques	6	4	10	90(T 40+P 50)	100
6.	**OpenEl ective**	PHY406(a)	1.Wireless Communications	6	4	20	80	100
		PHY406(b)	2. VacuumTech nology& Applications					
	Total			36	24	90	510	600

*AllcorepapersareMandatory

- GenericElective –Choosetwo
- CorepapersandGenericElectivesoptedpaperheldPractical-II.
- ProjectWork-Collaborationwithvariousfirms/companies/societies.
- Multi-Disciplinary CourseisMandatory.Circleformationwithothersubjects/Dept.ofArts/Commerce.
- Open Electives are for the students of other Departments. Minimum one paper should be opted.Extra credits may be earned by opting for more number of open electives depending on theinterest of the studentthroughself-study.
- Interestedstudentsmayregisterfor MOOCwith theapproval oftheconcerned DDC.

(MandatoryCore)

PHY-101	CLASSICALMECHANICS AND THEORY OF RELATIVITY	L-5,T-1,P-0	4Credits
Pre-requisite: Understandingofgraduatelevelphysics			
Course Objectives: The aim and objective of the course on **Classical Mechanics and theory of relativity** is to train thestudents of M.Sc. in the Lagrangian and Hamiltonian formalisms and relativity theory so that they can use thesein the modern branches of physics such as Quantum Mechanics, Quantum Field Theory, CondensedMatterPhysics, Astrophysics, etc.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	UnderstandthenecessityofAction, Lagrangian,andHamiltonianformalism.		
CO2	Used' DAlambertprincipleandcalculusofvariationstoderivetheLagrangeequationsof motion.		
CO3	DescribethemotionofamechanicalsystemusingLagrange-Hamiltonformalism.		
CO4	Applyessentialfeaturesofarelativityproblem(likemotionundercentralforce,periodicmotions) to set up andsolve theappropriate physics problems.		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	1	1	-	2	2	-	1
CO2	3	2	2	2	-	1	1	-	2	2	1	2
CO3	3	3	2	-	2	1	1	-	2	2	-	-
CO4	3	2	3	2	-	1	1	-	2	2	1	-

PHY101:ClassicalMechanicsand TheoryofRelativity

UNIT–I:LagrangianMechanics andHamiltonianMechanics

Newtonianmechanicsofoneandmanyparticlesystems:Conservationlaws:Constraintsandtheirclassification: Degrees of freedom: Generalized coordinates: Principle of virtualwork, D' Alembertsprinciple:Lagrange's equations ofmotion.

Applications: Inclined plane, Linear harmonic oscillator and simple pendulum: Hamiltonian principle:Lagrange's equation from Hamilton's principle: Hamilton's equation of motion: Applications: Simplependulum,Compound pendulum.

UNIT–II:CanonicalTransformationsandHamilton – JacobiTheory

Canonical Transformations; generating function; properties: Condition for transformation to be canonical;Illustration of canonical transformation: Poisson - Brackets; Canonical equations in terms of Poisson -Bracketnotation. Lagrange-Brackets andtheirproperties.

The Hamiltonian - Jacobi equation; one dimensional harmonic oscillator; Action Angle variables:

Keplerproblemin actionangle variables

UNIT–III:Motionin a CentralForceField

Reduction to the equivalent one body problem; Motion in a central force field: Conditions for closedorbits: Inversesquarelawofforces:Kepler'slaws ofplanetarymotion; Rutherfordscattering.

Rotations – Space and body fixed axes: Angular momentum and Torque; Eulerian angles–Euler'sequations of a rigid body: Motion of symmetrical top; Expression for slow and fast precessions; Larmourprecision;Examples ofGyroscope.

UNIT–IV:SpecialTheoryofRelativity

Introduction – Postulatesof Special Theory of Relativity – The principle of constancy oflight – TheLorentz transformations.RelativisticKinematics: The velocity transformations–Thetransformationsfor the acceleration of a particle.Relativity Optics: The aberration of the of the light from stars – TheDopplereffect.

Relativistic Mechanics: The mass of a moving particle – The relativistic dynamics of a single particle –Applications of relativistic dynamics of a single particle: Motion in electric field – Motion in a magneticfield–Experimentalverificationofthevariationofmasswithvelocity–Bucherer'sexperiment-Transformation ofmomentumand force.

BooksforStudy

1. ClassicalMechanics byN.C. Rana andP.S.JoagTataMc-grawHill(1991).
2. ClassicalMechanicsbyH.Goldstein,AddiWesely,(1980).
3. ClassicalMechanicsbyJ.C.Upadyaya,HimalayaPublishingHouse(2014).
4. ClassicalMechanicsbyGupta,Kumar andSharma,PragatiEdition,(2019).
5. Classical dynamicsofparticlesandsystemsbyJ.B.Marion,ThomsonBooks/cole,(2004).
6. IntroductiontoClassicalMechanicsbyR.G.TakwaleandP.S.Puranik,TataMc-grawHill,(2008).
7. TheoryofRelativitybyW.Pauli,Dover Publications,(2013).
8. IntroductiontothetheoryofrelativitybyP.G.Bergmann,Dover Publications(1977).
9. IntroductoryRelativitybyW.G.V.Rosser,LondonButterworths,(1967).

(MandatoryCore)

PHY-102	Solid State Physics	L-3,T-1,P-2	4Credits

Pre-requisite: Understandingofgraduatelevelsolidstatephysics

Course Objectives: The aim and objective of the course on **Solid StatePhysics** is toexpose the students of M.Sc.class to the topics like elastic constants, lattice vibrations, dielectricproperties, energy band theory and transport theory so that they are equipped with the techniquesusedin investigatingthesea aspects of thematterincondensedphase.

CourseOutcomes: At theend ofthe course, thestudent willbe ableto

CO1	Gainin-depthknowledge abouttheformationofvariouscrystalstructurevaperformingcalculationson theirelemental parameters.
CO2	Differentiatebetweenvariouslatticetypesbasedontheirlatticedynamicsandthenexplain thermal properties of crystalline solids.
CO3	Understand the electron motion in periodic solids and origin of energy bands insemiconductors.
CO4	To explain the basic transport theory for understanding the transport phenomenonin solids

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	2	-	1	-
CO2	2	3	2	2	2	2	2	-	-	-	1	2
CO3	3	3	2	2	1	2	2	-	1	-	1	-
CO4	3	3	2	2	2	2	1	-	-	-	1	2

PHY102:SolidState Physics

UNIT–I:Crystallography,LatticeEnergiesandLatticeVibrations

Bravaislattices–Reciprocal lattice –X-raydiffraction –structuralfactor.

Origin of chemical binding in ionic and van der Waals crystals – Elastic properties – Stress and strain –Elastic moduli - Lattice energy calculations for ionic and van der Waals crystals – Lattice vibrations:Mono anddiatomiconedimensionalinfinitelylonglattices–Quantizationoflatticevibrations–Phonons –Properties.

UNIT– II: TransportPhenomenaandBandTheory

Concept of electrical and thermal resistivity – Expression for thermal and electrical conductivities formetals – Lorenz number - Different scattering mechanisms – Matheissens rule- Distribution function -FormulationofBoltzmanntransportequation– Relaxationtime approximation.

Sommerfeld model – its consequences – electron-lattice interaction (Quantitative only) – Bloch function -Motion of electron in periodic potential –Kronig - Penny model – Formation of energy bands in solids –Brillouinzones–Conceptofeffectivemass –

Distinctionbetweenmetals,insulatorsandsemiconductors.

UNIT–III:SemiconductorPhysics

Intrinsicandextrinsicsemiconductors–ExpressionforpositionofFermilevelsandcarrier concentrations – Variation of Fermi level with temperature – np product – Carrier mobility, conductivity and theirvariation with temperature – Direct and indirect band gap semiconductors – Differences and examples –Hall effect - Continuity equation – Drift and Diffusion – Einstein relation – Generation, Recombinationand life time of non-equilibrium carriers – Heyness-Schockley experiment – Determination of life time,diffusionlength of minoritycharge carriers.

UNIT–IV:Superconductivity

Conceptofzeroresistance–Magneticbehavior–Distinctionbetweenaperfectconductorandsuperconductor–Meissnereffect–Isotopeeffect–Specificheatbehavior–Two-fluidmodel–Expression for entropy difference between normal and superconducting states – London's equations –Penetration depth – BCS theory –Josephson junctions – SQUIDS and its applications - Applications ofsuperconductors –High $T_C$superconductors–Preparation– Properties.

BooksforStudy

1. SolidStatePhysics, C.Kittel, Edition:8th 2012,JohnWiley&Sons.
2. SolidStatePhysics,A.J.Dekkar,Edition: 1st,2000.MacmillanIndiaLtd.
3. SolidStateElectronicDevices,B.G.Streetman.Edition7th,2018,PearsonEducationIndia
4. ElementarySolidStatePhysics,M.Ali Omar,1993,Addison-Wesley.
5. SolidStatePhysics,M.A.Wahab,Edition:3rd, 2020,NarosaPublishingHouse.
6. HighT_CSuperconductivity,C.N.R.RaoandS.V.Subramanyam,worldscientificpublishingcompany,1989
7. SolidStatePhysics,S.O.Pillai.Edition:6th,2009,NewAcademicScienceLtd
8. SolidStatePhysics,S.L.Kakani and C.Hemarajan,Edition: 4th,2005,Sultan Chand andSons
9. ElectronsinSolids,RichardH.Bube,Edition3rd,1992Elsevier,
10. SolidState PhysicsbyR.K. PuriV.K. BabbarEdition: 1st 2017. S.Chand.

(CompulsoryFoundation)

PHY-103(a)	Analog and Digital Electronics	L-5,T-1,P-6	4Credits
Pre-requisite: Basicknowledgeaboutelectronics			
Course Objectives: The aimandobjective ofthe course on**Analog and Digital Electronics** isto introduce thestudents of M.Sc. class to the formal structure of the subject and to equip them with the knowledgeofsemiconductorphysics,basiccircuitanalysis,first-ordernonlinearcircuits,OPAMPbasedanalog circuits and introduction to digital electronics so that they can use these in various branchesofphysicsas per their requirement.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	Understand working of Different Semiconductor devices (Construction,WorkingPrinciples andV-Icharacteristics)and their applications.		
CO2	Explaintheconstructionandworkingof Operational amplifiers and applications		
CO3	Design Digital circuits andtheirapplications.		
CO4	Understand the working of various analog communication techniques		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2	1	-	1	-	1	-
CO2	3	3	2	1	2	2	1	-	-	2	1	-
CO3	2	2	3	2	2	2	1	-	1	-	1	-
CO4	3	3	2	2	2	2	1	-		2	1	-

PHY103(a):AnalogandDigitalElectronics

UNIT–I:IntroductiontoElectronicDevices:

Field Effect Transistor (FET): Structure and working of JFET, Characteristics, and parameters ofJFET.AdvantagesofFETover BJT.FETasswitchandAmplifier-ApplicationofFETasvoltage variable resistor.Structure of MOSFET, depletion type and enhancement type, MOSFETCharacteristics,MOSFETasvariableresistor,ConceptofCMOS.Structure,workingand Characteristicsof UJT.Application ofUJTas aRelaxation oscillator.

UNIT–II:OperationalAmplifiers:

Block diagram of a typical Op-Amp, differential Amplifier, Comparator open loop configuration,invertingandnon-invertingamplifiers.Op-ampwithnegativefeedback,voltageshuntfeedback, effect of feedback on closed loop gain, input resistance, output resistance, CMRR,frequencyresponse, slewrate. InstrumentationAmplifier,integratoranddifferentiator.Waveformgenerators(Squareandtriangle). Filters (Low pass, high pass and Band pass). Analog to Digital data converters (ADC)andDigital to Analog conversion (DAC).

UNIT–III:DigitalElectronics

(CompulsoryFoundation)

CombinationalLogic:Multiplexers,Decoder,Demultiplexer,Dataselector,Multiplexer,Encoder . Sequential Logic:Flip–Flops, A1-bit memory, The RS Flip-Flop, JK Flip – Flop, JKMaster Slave Flip–Flops, T Flip-Flop, D Flip-Flop, Shift Registers, Serial-in Serial-out, Serial-inParallel-out,Parallel-inSerial-out,Parallel-inParallel-outRegisters.AsynchronousandSynchronousCounters.

UNIT–IV:CommunicationElectronics

Introduction to Modulation (AM & FM), Sampling Theorem, Low pass and Band pass signals,PAM, Channel BW for a PAM signal. Natural sampling, Flat-top sampling. Signal recoverythrough holding. Quantization of signals, PCM transmission, Quantization of noise, DifferentialPCM, Delta Modulation, Adaptive Delta modulation CVSD. Signal to noise ratio in PCM andDeltaModulations.

BooksforStudy

1. MicroElectronicsbyMillimanand Halkias.TMHPublications
2. OP-Amps&LinearIntegratedCircuits,byRamakanthA.Gayakwad,PHI,2ndEdition,1991.
3. DigitalSystems byRonald J. Tocci,6th Edition,PHI, 1999.
4. DigitalPrinciplesandApplicationsbyA.P.MalvinoandDonaldP.Leach,TataMcGraw-Hill, New Delhi, 1993.
5. PrinciplesofCommunications byTaub andSchilling,Mc-GrawHillPublication.
6. ElectronicDevicesandCircuitTheorybyRobertBoylestedandLouisNashdsky–JoseKanedy&Division.PHI,New Delhi, 1991
7. ElectronicPrinciples byMalvino, 6th Ed.TMH, 2017
8. Linear Integrated circuitsbyRoyChoudhry, Pearson,2018
9. Op-Amps – D.K. Mahesh, PHI

(CompulsoryFoundation)

PHY-103(b)	ComputationalMethods and C language	L-5,T-1,P-0	4Credits
Pre-requisite: Understandingofgraduatelevelphysics			
CourseObjectives: Theaimandobjectiveofthecourseon**Computational Methods and C language** istofamiliarize the students of M.Sc. students with the numerical methods used in computationandprogrammingusinganyhighlevellanguagesuchasC,etc.,sothattheycanusetheseinsolvingsimple physicsproblems.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	Applybasicsknowledgeofcomputationalphysicsinsolvingthephysicsproblems.		
CO2	ProgrammewiththeCor anyother high-level language.		
CO3	Usevarious numericalmethodsin solvingphysics problems.		
CO4	Analyzetheoutcomeofthealgorithm/program graphically.		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	1	-	1	2	-	1
CO2	3	3	3	1	2	1	-	-	3	2	-	1
CO3	3	3	3	2	2	1	1	-	1	2	-	1
CO4	3	3	3	-	-	2	-	-	2	2	-	1

PHY103(b):ComputationalMethods&CLanguage

UNIT–I:(a) Fundamentalsof Clanguage

Ccharacterset–Identifiersandkeywords–Constants–Variables–Datatypes–Declarationsofvariables–Declarationofstorageclass–Definingsymbolicconstants–Assignmentstatement.Operators:Arithmeticoperators–Relationaloperators–Logicoperators–Assignmentoperators–Incrementand decrementoperators–Conditional operators.

(b) ExpressionsandI/Ostatements: Arithmeticexpressions–Precedenceofarithmeticoperators–Typeconvertersinexpressions–Mathematical(library)functions–Datainputandoutput -Getchar andputcharfunctions– Scanf–Printf–Simple programs.

(c) Control statements: If-Else statement – Switch statement – The? operator – GO TO – While, Do-while, FOR statements – BREAKandCONTINUEstatements.

UNIT–II:(a)Arrays

One dimensional and two-dimensional arrays – Initialization – Type declaration – Inputting andoutputtingofdata forarrays– Programsofmatrices addition,subtractionand multiplication.

(b) User Define functions: The form of C functions – Return values and their types – Calling afunction – Category of functions.Nesting of functions.Recursion.ANSI C functions –Functiondeclaration.Scopeand lifetime of variables infunctions.

(c) Pointers: Accessingtheaddressofvariable.DeclarationandInitializationofpointervariables. Accessing the value of the variable through its pointer.Pointer Expressions-PointersandArrays – Pointers and structures.

(CompulsoryFoundation)

UNIT– III:Linearandnon-linearequations

(a) Solution of Algebraic and transcendental equations – Bisection, Falsi position and Newton-Rhapsonmethods– Basicprinciples– Formulae–Algorithms.

(b) Simultaneous equations: Solutions of simultaneous linear equations – Gauss eliminationandGauss-Seidel iterativemethods -Basic principles –Formulae–Algorithms

UNIT–IV:(a)Interpolations

Concept of linear interpolation – Finite differences – Newton's and Lagrange's interpolationformulae –Principles and Algorithms Curve fitting – regression – Least squarefitting – Linearandquadratic**.**

(b) Numericaldifferentiationandintegration: Numericaldifferentiation – algorithmforevaluation of first order derivatives using formulae based on Taylor's series – Numericalintegration– Trape zooidal and Simpson's1/3 rule – Formulae– Algorithms.

(c) Numericalsolutionofordinarydifferentialequations: Euler,method,FourthorderRunga-KuttaMethod.

BooksforStudy

1. Programmingwith'C'–Byron Gottfried, 4th Edition,TataMcGraw Hill, 2010.
2. Programmingin'C' –Balaguruswamy,8th Edition,TataMcGraw-Hill,1990.
3. NumericalMethods,E.Balaguruswamy, TataMc GrawHill,1999.
4. Computer orientednumerical methods–Raja Raman,4th Edition,PHILearning,2018.
5. LetUsC,YeswanthKanetkar,17th Edition,InfinitySciencePress,2008.

(CompulsoryFoundation)

PHY-103©	SensorsandTransducers	L-3,T-1,P-2	4Credits
Pre-requisite: Understandingofgraduatelevelphysics			
CourseObjectives: TheaimandobjectiveofthecourseonSensorsandTransducers istofamiliarize the students of M.Sc. students with the various electronic sensors used in the industry and to understand the working principles of the sensors so that they can design and use them in industry or in real time applications.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	Applybasicsknowledgeofsensors and transducersinunderstanding the measurement systems.		
CO2	Study and understanding of various types of sensors		
CO3	Study and understanding of various types of Transducers		
CO4	Analyzetheoutcomeofthesignal conditioners like filters, detectors and amplifiers		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	1	-	1	2	1	1
CO2	3	3	3	1	2	1	1	-	-	-	1	1
CO3	3	3	3	2	2	1	1	-	-	-	1	1
CO4	3	3	3	3	2	2	2	-	2	-	1	1

PHY103(c):SensorsandTransducers

UNIT–I:GeneralIntroduction tosensors/transducers

Definition of a transducer/sensor.Role of a transducer in a generalized measurement system.Classification of transducers.Classification of transducers.Significant parameters of transducer.Temperaturescales.Mechanicaltemperaturesensors.Platinumresistancethermometer.Thermistors.Thermocouples.

UNIT–II:Displacementandstrain transducers

Displacementtransducers-Variableresistance,inductanceandcapacitance.Linearvoltagedifferential Transformer (LVDT) Strain- Definition, Principal of working of strain gauges.Gaugefactor. Types of strain gauges.Materials for strain gauges.Temperature compensation.Application

UNIT–III:Opto-electronictransducers

Photoemission tube.Photomultiplier cell.Photoconductive cell.Photovoltaic cell (solar cell).Photodiode,Photo–transistor,PhotoFET,Lightemittingdiode.Liquidcrystaldisplay.Optoelectronic couplers.Laser diode.

UNIT–IV:Singleconditioners(Filters, Detectors&Amplifiers)

Filters – Integrators, Differentiators and active filters. Detectors Peak Detectors sample and _hold circuits. Phase sensitive detector and precision rectifiers, Amplifiers– chopper stabilizedDC amplifiers. Instrumentation amplifiers. Logarithmic and anti-logarithmic amplifiers Isolationamplifiers, Lock in amplifiers.

BooksforStudy

1. InstrumentationMeasurementAnalysis,NakraandChaudary,4th Edition,TataMcGraw-Hill,1985.
2. Instrumentation-DevicesandSystems,Rangan,ManiandSharma,2nd Edition,TataMcGrawHill,1983.
3. A course in Electrical and Electronic Measurements and Instrumentation, AK Sawhney, 4th Edition,DhanpatRai&Company, 2016.
4. InstrumentalMethodsofAnalysis,Willard,Meritt,DeanandSeattle,7th Edition,VanNostrand,1981.
5. HandBookofBiomedicalInstrumentation,RSKhandpur,3rd Edition,Tata McGraw-Hill,1987.
6. Fundamentalsof ElectronicDevices,DavidA.Bell,5th Edition,OxfordUniversityPress,2008.
7. AnintroductiontoOperationalamplifiers,SVSubramanyam,2nd Edition,MacmillanIndia,1980.

PHY-104(a)	AtomicandMolecularPhysics (ElectiveFoundation)	L-5,T-1,P-0	4Credits

Pre-requisite: Understandingof graduatelevelspectroscopy

Course Objectives: The aim and objective of the course on **Atomic and Molecular Physics** forthestudentsofM.Sc.Physicsistoequipthemwiththeknowledgeof Atomic,Rotational,Vibrational,Raman, andElectronicspectra.

CourseOutcomes: At theend ofthecourse, thestudent willbe ableto

CO1	Havethebasicknowledgeof different atomic models, quantum nos and atomic spectra.
CO2	Understand the classical/quantumdescriptionof effect of magnetic field and Electric field on spectral lines.
CO3	Know the different types of rotation of the molecules and rotational constants and intern structure of the molecules.
CO4	Study the vibrational spectra of molecules and applications of vibrational spectra of molecules and applications of vibrational spectra

Mappingof courseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	2	-	-	2	1	-	1
CO2	3	2	3	3	-	2	2	-	2	1	-	1
CO3	3	2	3	3	2	2	-	-	2	-	-	1
CO4	3	2	3	3	-	2	2	-	2	-	-	1

PHY104(a):AtomicandMolecularPhysics

UNIT-I:AtomicSpectra

Introduction: Hydrogen atom (one electron atom) - quantum numbers- Spectra of hydrogen atom-Spectraof alkali elements- Fine structure-Elements with more than one valence electron- Forbidden transitionsand selection rules- Vector atom model– Spin-orbit interaction energy- Stern-Gerlach experiment-Experimental setup to demonstrate S-G - Coupling schemes- Spectralterms and termsymbols based onelectron configuration - LS coupling - JJ coupling- Interaction energies in LS and JJ couplings - Hund’sruleofmultiplicity-Pauli’sexclusionprinciple-Equivalent andnon-equivalentelectronicsystems.

UNIT-II:ZeemanandStarkEffects

Introduction: Zeeman effect- Normal and anomalous Zeeman effects - Experimental details – Magneticmoment of atom and Lande’s ‘g’-factor - Zeeman effect in sodium atom - Lande g-formula for LS and JJcouplings-Paschen-Backeffect-Splittingofsodiumlinesandselectionrules-Starkeffect-Experimental details - Weak and strong field effects – linear and quadratic Stark effects-Width ofspectrallines.

UNIT-III:DiatomicMolecularSpectroscopy–RotationalEnergies

Introduction–Rotational,vibrational,electronicspectraof diatomicmolecules–types ofmolecules–Linear,symmetrictop,asymmetrictopandsphericaltopmolecules –Rotationalspectraof a diatomic molecule as rigid rotator– Energy levels and spectra of non-rigid rotor –Intensity of rotationallines-Rotational spectra of polyatomicmolecule–Rotationalanalysisofelectronicspectra-Evaluation of rotational constants-Effectof isotopicsubstitutiononrotationallevels–Starksplitting of rotational lines–Starkmodulatedmicrowavespectrometer – Applicationsofrotationalspectroscopy

UNIT-IV:DiatomicMolecularSpectroscopy –VibrationalSpectra

Introduction–Vibrationalspectraofdiatomic molecule–Diatomic moleculeas simpleharmonicoscillator–An harmonicoscillator–Energylevelsandspectrum– Moleculeasvibrating rotator – PQR branches – progressions and sequences –Vibrationalanalysis ofelectronicspectra-Deslander'stable–Evaluationofvibrationalconstants–Morsepotentialenergycurve – Frank-Condonprinciple – Intensity distribution inabsorptionandemission spectra - Effectofisotopicsubstitutiononvibrationalbands–IR spectrometer–FTIRspectroscopy–Principle–Interferometerarrangement–advantages-Applicationsofvibrationalspectroscopy

BooksforStudy

1. IntroductiontoAtomicSpectra,H.E.White,McGraw-HillKogakusha.Ltd.,NewDelhi(1934).
2. ElementsofSpectroscopybyGupta,Kumar,Sarma,PragatiPrakasan,(2012).
3. FundamentalsofMolecularSpectroscopy,C.N.BanwellandE.M.McCash,TataMcGraw-HillPublishingCompanyLtd., NewDelhi.(1994).
4. Spectroscopy,VolumeIandIII,B.P.StraughanandS.Walker,JohnWiley&SonsInc.,NewYork.(1976).
5. IntroductiontoMolecularSpectroscopy,G.M.Barrow,McGraw-HillBook company,Inc.,NewYork. (1962).
6. SpectraofDiatomicMolecules,G.Herzberg,D.VanNostrandCompanyInc,NewYork,(1950).
7. MolecularSpectroscopy,J.M.Brown,OxfordSciencePublications,Oxford.(1998).
8. Molecular Structure and Spectroscopy, G. Aruldhas, Prentice- Hall of India, Pvt., New Delhi,(2005).

PHY-104(b))	**Optical,MicrowaveandSatelliteCommunications** (ElectiveFoundation)	**L-3,T-1,P-2**	**4Credits**

Pre-requisite: Understandingof graduatelevelBasic Electronics

Course Objectives: The aim and objective of the course on Optical,MicrowaveandSatelliteCommunicationsforthestudentsofM.Sc.Physicsistoequipthemwiththeknowledgeof Optical, microwave and satellite Communications.

CourseOutcomes: At theend ofthecourse, thestudent willbe ableto

CO1	understand microwave communication system
CO2	Understand functioning of Radar systems
CO3	Study different digital modulation techniques
CO4	Differentiate losses in optical fiber link and state transmission characteristics of optical fiber

Mappingof courseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	1	-	2	-	-	-
CO2	3	3	3	3	2	1	2	-	1	2	-	-
CO3	3	3	3	3	2	1	2	-	1	-	-	-
CO4	3	3	3	3	2	1	2	-	2	2	-	-

PHY104(b):Optical,MicrowaveandSatelliteCommunications

UNIT– I:MicrowaveCommunications

Advantages and Disadvantages of microwave transmission, loss in free space, propagation ofmicrowaves,atmosphericeffectsonpropagation,Fresnelzoneproblem,groundreflection,fadingSources, Detectors,components, antennaeusedin MWcommunicationsystems.

UNIT–II:RadarSystems

Radarblockdiagramandoperation,radarfrequencies,pulseconsiderations.Radarrangeequation, derivation of the radar range equation, minimum detectable signal, receiver noise,Signal to noise ratio, Integration of radar pulses, Radar cross section, Pulse repetition frequency,Antennaparameters,SystemLossesandpropagationlosses,Radartransmitters,receivers,Antennas,Displays.

UNIT-III:DigitalCommunications

Digital Communications:Principles of digital communications, digital radio, frequency shiftkeying,phaseshift keying, quadratureamplitudemodulation.

UNIT–IV:OpticalandSatelliteCommunications

OpticalCommunications:Opticaltransmitterandreceiverforanaloganddigitalcommunications, coherent and non-coherent detection, signal to noise ratio, error rate, coding,synchronizationand equalization in optical datatransmission.

SatelliteCommunications:Orbitalsatellites,geostationarysatellites,orbitalpatters,lookangles,orbital spacing, satellite systems,Linkmodules.

BooksforStudy

1. MicroelectronicsbyJacobMillman,2nd Edition,McGraw-HillInternationalBookCo.,NewDelhi, 1990.
2. Optoelectronics:TheoryandPractice,editedbyAllenChappel,11th Edition,McGrawHill,International BookCo., New York,1978.
3. Microwaves”byK.C.Gupta,2nd Edition,WileyEasternLimited,New Delhi,1979.
4. AdvancedElectronicsCommunicationsSystemsbyWayneTomasi,6th Edition,PrenticeHall,1998.

(ElectiveFoundation)

PHY-104(C)	Computer Architecture and Networking	L-5,T-1,P-0	4Credits
Pre-requisite: Understandingof graduatelevelBasic Physics and Electronics			
Course Objectives: The aim and objective of the course on Computer Architecture and Networking forthestudentsofM.Sc.Physicsistoequipthemwiththeknowledgeof Computer architecture and working and also various networking protocols.			
CourseOutcomes: At theend ofthecourse, thestudent willbe ableto			
CO1	Understand basics of logic circuits and computer functional blocks		
CO2	Know machine instructions and assembly languages		
CO3	Comprehend I/O organization		
CO4	Appreciate differences between different memory devices		

Mappingof courseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	2	1	1	-	2	1	-	-
CO2	3	2	-	3	2	1	2	-	2	1	-	-
CO3	3	2	-	3	2	1	2	-	2	1	-	-
CO4	3	2	-	3	2	1	2	-	2	1	-	-

PHY104(c):ComputerArchitectureandNetworking

UNIT– I:LogicCircuits

Logic functions – synthesis of logic functions – Minimization of logic - Synthesis with NANDand NOR gates – Implementation of Logic gates – Flip-Flops – Registers and shift registers –counters – decoders – multiplexers – PLDs – sequential circuits.Basic structure of computers:Functional units – Basic operational concepts – Bus structures performance – Multiprocessorsandmulti computers.

UNIT–II:MachineInstructionsandprograms

Numbers, arithmetic operations and characters – memory locations and address, operations – Instructionsandinstructionsequencing–addressingmodes–assemblylanguage– basicinput/outputoperations–subroutines–encodingofmachineinstruction.Instructions– assemblylanguages–O/Ioperations-registers andaddressing–instructions–assemblylanguage –instructionsof68000andIntelPentium.

UNIT–III:Input/outputorganization

Accessing I/O devices – interrupts – direct memory access – buses 240 interface circuits – standard I/O interface.

UNIT– IV:Memory System

Concepts semiconductor RAM memories – Randomly memories - cache memories performanceconsiderations – virtual memories – memory management requirements – secondary storagearithmetic: addition and subtraction of signed numbers – design of fast adders – multiplication ofpositivenumbers–signedoperandmultiplication–fastmultiplication–integerdivision
–floatingpointnumbers andoperations.

BooksforStudy

1. HamacherCVranesicZandZakyS.ComputerOrganization,5th Edition,McGrawHill2002.
2. StallingsW.ComputerOrganizationandArchitecture6th Edition,PearsonEducation2003
3. ManoMM, Computer SystemArchitecture3rd EditionPhi 1993
4. YarbroughJ.M.Digital LogicApplicationsand Design,Thomas Learning1997
5. HeuringVPandJordan HFComputerSystemsDesignandArchitecture,PearsonEducation 1977

(MandatoryCore)

PHY201	**StatisticalMechanics**	**L-5,T-1,P-0**	**4Credits**

Pre-requisite: Understandingofgraduatelevel statisticalmechanics

Course Objectives: The aim and objective of the course on **Statistical Mechanics** is to equip theM.Sc. student with the techniques of statistical ensemble theory so that he/she can use these tounderstandthemacroscopicpropertiesofthematterinbulkintermsofitsmicroscopicconstituents.

CourseOutcomes: At theend ofthe course, thestudent willbe ableto

CO1	Use ensemble theory to explain the behavior of Physical systems
CO2	Understanding
CO3	ExplainthestatisticalbehaviorofBose-Einstein andtheirapplications.
CO4	Fermi –Dirac Statistics & Fluctuations

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	3	2	1	-	1	-	1	-
CO2	3	3	3	1	3	-	1	-	-	1	-	-
CO3	3	3	3	-	2	-	1	-	-	-	-	-
CO4	3	3	3	-	2	2	1	-	-	-	1	-

PHY201:StatisticalMechanics

UNIT-I:Ensembles

Phase space – Concept of ensembles – Types of ensembles - Ensemble average - Liouville'sTheorem – Microcanonical ensemble: ideal gas – Gibb's paradox and its resolution – Entropyand probability – Canonical ensemble – Ideal gas in canonical ensemble –Grand canonicalensemble–Idealgas ingrandcanonicalensemble–Comparisonofvariousensembles.

UNIT–II:PartitionFunctions

Canonical partition function – Molecular partition function – Transnational partition function –Rotational partition function – Vibrational partition function – Electronic and Nuclear partitionfunctions – Applications of Rotational partition function – Applications of vibrational partitionfunctionto solids

UNIT–III:Maxwell –BoltzmannandBose –Einstein Statistics

Maxwell-Boltzmann distribution-Distributionofvelocities–Experimentalverification-Calculationofmeanvalues–Equipartitionenergy-Bose–Einsteindistribution,Bose–Einstein condensation, Black body radiation and the Planck’s radiation law - Dulong and Petit’slaw - Einstein and Debye’s theories of heat capacities - Liquid helium – Two fluid model ofliquidhelium II– Super fluid phaseof ^{3}He.

UNIT–IV:Fermi –DiracStatistics& Fluctuations

Fermi - Dirac distribution – Electrons in metals – Thermionic emission – Magnetic susceptibilityof free electrons – White dwarfs – Fluctuations in ensembles, Onsagar’s one dimensional andreciprocalrotationsandtheirapplicationsto thermos electricphenomena,Kelvin’sfirstandsecondequations: Onedimensionalrandom walk–Random walk andBrownian motion.

BooksforStudy

1. StatisticalMechanicsbyB.K.Agarwal,MelvinEisner-PublisherJohnWiley&Sons,1988
2. StatisticalMechanicsandpropertiesofMatterbyESRGopal–PublishersEllisHorwood,1974
3. StatisticalandThermalPhysicsbyF.Reif-Publisher WavelandPress,2009
4. ElementaryStatistical Mechanics byC.Kittel-Dover Publications, 2012
5. StatisticalPhysicsbyBhattacharjee,AlliedPublishersLimited,2000
6. ThermalPhysics byKittelandKremer –W.H. Freeman andCompany, 1980

(MandatoryCore)

PHY- 202	ElectromagneticTheory,LasersandModern Optics	L-3,T-1,P-2	4Credits

Pre-requisite: Understandingofgraduatelevelopticsand Lasers

Course Objectives: Course Objectives: The aim and objective of the course onElectromagneticTheory,LasersandModernOpticsis to expose the M.Sc. students to the basics of the challenging researchfieldof optical fibres andtheir usein nonlinear optics.

CourseOutcomes: At theend ofthe course, thestudent will be ableto

CO1	Understandthe electro statistics and magneto statistics and also the properties of propagation of electromagnetic radiation in different media
CO2	Know about the properties of laser beam and the working of different lasers and applications
CO3	Describe the fourier analysis in optics problems and to understand the concept of holography
CO4	Analyze the propagation of light in optical fibers and to know the various applications of optical fibers

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	2	1	1	-	**1**	1	**-**	-
CO2	3	2	2	1	2	1	-	-	**1**	1	**-**	-
CO3	3	3	3	-	2	1	2	-	**1**	1	-	-
CO4	3	2	3	2	3	-	2	-	**1**	1	-	-

PHY202:ElectromagneticTheory,LasersandModernOptics

UNIT– I: ElectromagneticTheory

Electromagneticradiation;Introductiontoelectrostaticsandmagnetostatics–Electrodynamics: emf – electromagnetic induction – Maxwell’s equations in differential and integral forms- Retarded potentials – Radiation from moving point charge and oscillating dipoles – Linearantenna–Radiationresistance –electricquadrupole radiation - Lienard – Wiechertpotentials.

General wave equation – Propagation of light in isotropic dielectric medium – Dispersion – Propagationof lightinconducting medium- skindepth–Reflectionandrefractionattheboundary of a dielectricinterface– Fresnel’s equations– Propagationof lightincrystals-Doublerefraction.

UNIT–II: LasersandNon-LinearOptics

Introduction to lasers – Spontaneous and stimulated emission – Laser beam properties – Einsteincoefficients – Population inversion – Pumping schemes – Losses in laser radiation – Thresholdcondition for laser oscillation – Laser cavity - Q factor– different experimental methods – Rubylaser-GaAslaser-He-Nelaser–Argon ionlaser– CO_2laser–Laser applications.

Basic Principles – Origin of optical nonlinearity - Harmonic generation – Second harmonicgeneration–Phasematchingcondition–Thirdharmonicgeneration–Opticalmixing– Parametric generation of light – Parametric light oscillator – Frequency up conversion – Selffocusingof light -Guidedwaveoptics-Pulse compression -Optical solutions.

UNIT–III:HolographyandFourierOptics

Introduction to Holography – Basic theory of Holography – Recording and reconstruction ofHologram–Diffuseobjectillumination–Specklepattern–FrenelandFouriertransformHolography– Applications of Holography.

Introduction to Fourier optics – Two dimensional Fourier transforms – Transforms of Dirac-deltafunction – The convolution integral – convolution theorem- Spectra and correlation – Parsevel'sformula–Apodization–Arraytheorem–Fouriermethodsindiffraction-Fraunhoufferdiffractionofsingle slit,double slit andtransmission gratingusingFouriermethod.

UNIT–IV:FiberOptics

Total internal reflection - Optical fiber modes and configuration – Single mode fibers – Gradedindex fiber structure – Fiber materials and fabrication – Mechanical properties of fibers – Fiberoptic cables – Attenuation – Signal distortion on optical wave guides - Erbium doped fiberamplifiers – Solitons in optical fibers - Block diagram of fiber optic communication system -Applicationsof optical fibers in communication and medicine.

BooksforStudy

1. IntroductiontoElectrodynamics,D.J.Griffiths,Prentice-Hall, India,2015
2. Electromagnetics, B.B. Laud,Wiley-Eastern,NewDelhi,2011
3. IntroductiontoModernOptics,G.R. Fowels,2012
4. LasersandtheirApplications,M.J.Beesly,TaylorandFrancis,1976
5. Lasersand Non-LinearOptics,B.B.Laud,WileyEastern Ltd.,1983
6. Optics,E.Hecht,AddisonWiley,1974
7. OpticalFiberCommunications,G.Keiser,McGrawHillBook,2000

(CompulsoryFoundation)

PHY-203(a)	**NuclearPhysics**	**L-5,T-1,P-0**	**4Credits**
Pre-requisite: Understandingof graduatelevel physics			
Course Objectives: The aim and objective of the course on **Nuclear Physics** is to familiarize the students of M.Sc. class to the basic aspects of Nuclear Physics like static properties of nuclei,radioactive decays, nuclear forces, nuclear models, and nuclear reactions so that they are equippedwiththe techniques usedin studyingthesethings.			
CourseOutcomes: Attheend ofthecourse,the studentwill be able to			
CO1	Understand the basics of nuclear forces and their characteristics and also about various nuclear models		
CO2	Know the various types of nuclear reactions and nuclear decay system		
CO3	Understand the basic principles in nuclear accelerators and rectors and also their applications		
CO4	Describe the various elementary particles and their conservation layers.		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	1	1	-	-	2	2	-
CO2	3	3	2	1	2	1	1	-	1	-	2	-
CO3	3	3	2	1	2	1	1	-	-	-	2	-
CO4	3	3	2	1	2	1	1	-	-	2	2	-

PHY203 (a):NuclearPhysics

UNIT– I: NuclearForcesandModels

NuclearForces: Characteristicsofnuclearforces–GroundstateofDeuteron–Proton–Protonscattering–Neutron – Proton scattering–Meson theoryof nuclearforces.

NuclearModels: Introduction–Theliquiddrop model–Bethe-Weizackersemi-empiricalbindingenergy equation and its applications – Nuclear shell model – Energy levels and calculation of angularmomentum– Collective model.

UNIT–II:NuclearReactionsandDecays

NuclearReactions: Typesofnuclearreactions–Compoundnuclearreactions–Nuclearcrosssection–Resonancetheory– BrietWignerformula.

NuclearDecays: Nucleartransformations–Radioactivedecay–Alphadecay–Gamow’stheory–Betadecay–Fermi theory–Selectionrules – Interactionofgamma radiationwithmatter–Photoelectriceffect –Comptonscattering–Pairproduction.

UNIT–III:NuclearAcceleratorsandReactors

Nuclear Accelerators: Introduction – Linear accelerators – Drift tube and Wave guideaccelerators – Lowenergycircularaccelerators–CyclotronandBetatron–Highenergycircularaccelerators–SynchrotronandMicrotron.
Nuclear Reactors: Nuclear fission and fusion reactions – Nuclear chain reactions – Four factor formula –The critical size of a reactor – General aspects of reactor design – Classification of reactors – Powerreactors(elementaryaspects only).

UNIT–IV:**ElementaryParticles**

Discovery andclassificationofelementary particles–Typesofinteractions –Conservation laws–Iso-spin, parity, charge conjugation – Time reversal – CPT theorem – Properties of leptons, mesons andbaryons – Elementary particle symmetries (SU_2 and SU_3 symmetries) – Quark model – Search for Higg'sparticle –elementaryideas.

Bookfor Study

1. NuclearPhysics,IrvingKaplan,NarosaPub.(1998).
2. NuclearPhysics,Theoryandexperiment–P.R.RoyandB.P.Nigam,NewAgeInt.1997.
3. AtomicandNuclearPhysics(Vol.2), S.N.Ghoshal,S. Chand&Co.(1994).
4. NuclearPhysics,D.C.Tayal,HimalayaPub.(1997).
5. AtomicandNuclear Physics,R.C. Sharma,K. Nath&Co.,Meerut(2007).
6. NucleiandParticles,E.Segre,WABenjamin. Inc.,(1965).
7. IntroductiontoNuclearPhysics,H.A.Enge,AddisonWesley(1975).
8. IntroductiontoNuclearPhysics,K.S.Krane,JohnWiley&Sons(1988).

(CompulsoryFoundation)

PHY-203(b)	IC fabrication Techniques	L-5,T-1,P-0	4Credits
Pre-requisite: Understandingof graduatelevelphysics			
Course Objectives: The aim and objective of the course on **IC fabrication Techniques** is to familiarize thestudents of M.Sc. class to the basic aspects of IC fabrication, different techniques in preparing and processing of IC technology and deposition techniques.			
CourseOutcomes: Attheend ofthecourse,the studentwill be able to			
CO1	Understand and compare crystal growth and Epitaxial deposition techniques		
CO2	Understandstructureandprocess of oxidation		
CO3	Study the diffusion processes		
CO4	Understand vacuum deposition techniques		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	2	1	1	-	-	2	2	-
CO2	3	3	2	1	2	1	1	-	1	2	2	1
CO3	3	3	2	-	-	1	1	-	-	2	2	-
CO4	3	3	2	1	2	1	1	-	1	2	2	1

PHY 203 (b): IC Fabrication

TechniquesUNIT– I:ICFabrication Technology

Wafer preparation:Silicon crystal growth, Wafer orientation, Sawing and polishing, Crystalorientation,Dopingof crystals duringgrowth.

Epitaxial deposition:Introduction theory, Growth of an Epitaxial layer, evaluation of Epitaxiallayers.

UNIT– II: Oxidation

Introduction,equipmentforthermaloxidation,oxidationprocess,oxideevaluation,recentadvance sinoxidationtechnology,oxidethicknessdetermination,oxidationfunction,redistribution ofdopantatoms duringthermaloxidation, anodicoxidation.

UNIT-III:Impurity

Introduction and redistribution, the idea of diffusion, diffusion process, diffusion analysis, ionimplementation,

UNIT–IV:Photomasking

Introduction – generation of photomask. Metallization:Metallization of requirements, vacuumdeposition,deposition techniques, vacuum deposition cycle.

BooksforStudy

1. InstrumentationMeasurementandAnalysisbyNakra andChoudary,4th Edition,TataMcGraw-Hill,1985.
2. Instrumentation–DevicesandSystemsbyRangan,SarmaandMani,2nd Edition,TataMcGraw-Hill, 1997.
3. MeasurementofSystemsApplicationsandDesignbyEarnestO.Doeblin,7th Edition,McGraw-Hill,1990.
4. AcourseinElectrical;andElectronicMeasurementsandInstrumentationbyA.K.Sawhney, 3rd Edition, DhanpatRai&Company, 2016.
5. ElectronicInstrumentationandMeasurementsTechniques,CooperandAlbertD.Helfriek, 3rd Edition, PearsonIndia Education, 2016.
6. AppliedElectronics byG.K. Mithal, 20th Edition,KhannaPublishers, 1997.
7. PrinciplesofIndustrialInstrumentationbyD.Patranabis,TataMcGraw-Hill,1976.

(CompulsoryFoundation)

PHY-203(c)	AdvancedMicroprocessorsandItsApplications	L-3,T-1,P-2	4Credits
Pre-requisite: Understandingof graduatelevelphysics			
Course Objectives: **The aim and objective of the course on AdvancedMicroprocessorsandItsApplications** is to familiarize thestudents of M.Sc. class to the basic aspects of microprocessors and different programming and interfacing techniques.			
CourseOutcomes: Attheend ofthecourse,the studentwill be able to			
CO1	Understanding of microprocessor architecture and evaluation		
CO2	Develop skill of writing programs in ALP for various applications of 8085 & 8051		
CO3	Interface various peripherals with 8085 & 8051.		
CO4	Understanding interrupts and direct memory access		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	1	-	1	2	-	-
CO2	3	3	-	2	2	1	1	-	-	2	2	-
CO3	3	3	2	1	2	1	1	-	-	2	-	-
CO4	3	3	1	-	2	1	1	-	1	2	2	-

PHY203(c):AdvancedMicroprocessorsandItsApplications

UNIT–I:MicroprocessorsanditsArchitecture

Internal microprocessor architecture, Real mode and protected modes of memory addressing,Memorypaging.

Addressingmodes-Data addressing modes, program memory – addressing modes, Stack - memoryaddressingmodes.
Instruction Set - Data movement instruction, Arithmetic and logic Instruction, Program controlinstructions,Assembler details.

UNIT–II:ProgrammingtheMicroprocessor

Modularprogramming,usingthekeyboardandvideodisplay,Dataconversions.
Hardware Specifications - Pin - outs and the pin functions, clock - generator (8284A), Busbuffering and latching, Bus timing, Ready and Wait state, Minimum mode versus maximummode.

UNIT–III:MemoryInterface

(CompulsoryFoundation)

Memorydevices,Addressdecoding,8088and80188(8-bit)memoryinterface,8086,80186, 80286and 80386 (16-bit)memoryinterface.

Basic I/O Interface - Introducing to I/interface, I/O port address decoding, 8255,8279, 8254,ADC and DAC (excludingmultiplexed display& keyboard displayusing8255).

UNIT–IV:Interrupts

Basicinterruptprocessing,Hardwareinterrupts,expandingtheinterruptstructure,8259APIC.
DirectMemoryAccess-Basic DMAoperation, 8237DMAcontroller.
BusInterface -PCIbus.

BookforStudy

1. B.B. Brey, "The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486,Pentium and Pentium pro processor architecture, programming and interfacing", 4/e, PHI,1999.
2. K.J.Ayala,"The8086Microprocessor:Programming&InterfacingthePC"PenramInternational Publishing(India) Pvt.Ltd., 1995.
3. DouglasV.Hall,"MicroprocessorsandInterfacing,ProgrammingandHardware",2/e,Mc Graw Hill,International Edition, 1992.
4. MuhammadAliMazidiandJanice GillispieMazidi,"The80x86IBMPCandCompatibleComputers,(VolumesI&II)". 2/e, Printice–Hall,Inc., 1998.
5. WalterA.TriebelandAvatarSingh,"Software, HardwareandApplications"PHI,1995.
6. YuChengLinandGlennA.Gibson,"Microcomputersystems:The8086/8088FamilyArchitecture,ProgrammingandDesign", PHI,1992.

(ElectiveFoundation)

PHY204(a)	**MathematicalPhysics**	**L-5,T-1,P-0**	**4Credits**
Pre-requisite:Understandingofgraduatelevelmathematics			
Course Objectives: The aim and objective of the course on **Mathematical Physics** is to equiptheM.Sc.Studentswiththemathematicaltechniquesthathe/sheneedsforunderstandingtheoreticaltreatmentindifferentcoursestaughtinthisclassandfordevelopingastrongbackgroundif he/she chooses to pursueresearch inphysics asacareer.			
CourseOutcomes: At theend ofthecourse,the studentwillable to			
CO1	Understand the basics and applications of special functions in all the branches ofPhysics.		
CO2	UseFourierseriesandtransformationsasanaidforanalyzingphysicalproblems.		
CO3	Applyintegraltransform tosolvemathematicalproblemsofPhysicsinterest.		
CO4	Formulate and express a physical law in terms of complex variables and simplify it by use ofcoordinatetransforms.		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	2	-	1	1
CO2	3	3	2	2	-1	-	1	-	2	-	1	-
CO3	3	3	2	-	1	1	1-	-	2	-	1	-
CO4	3	3	2	2	2	1	1	-	2	-	1	2

PHY204(a):MathematicalPhysics

UNIT-I:SpecialFunctions

Beta and Gamma Functions – Definitions and properties – Evaluation of integrals, Legendre,Besseland Hermite differentialequations– Solutions– Generating functions– OrthogonalpropertiesofLegendre,BesselandHermiteFunctions(Proofnotnecessary)– Recurrencerelations– (ProofforLegendrepolynomials only).

UNIT-II:IntegralTransforms

Fourier Transforms: Properties of Fourier transforms – Fourier sine and cosine transforms-Power in Fourier series – Modulation theorem, Fourier transform of impulse function, Constants,Unitstep function and Periodicfunctions.
Laplace Transforms: Definition and notation – Properties of Laplace transforms – Laplacetransforms of Dirac delta function and periodic functions (Square wave, sawtooth wave andtriangular wave) –InverseLaplace transforms– properties– Solution of linear differentialequations with constant coefficients - Applications to LCR circuits and resonance of simplependulum.

UNIT-III:NumericalTechniques

(ElectiveFoundation)

Solution of an equation – Bisection method, Regular False method, Newton – Rhapson methodSolutions ofsimultaneous– Gauss elimination method and Gauss-Seidelmethod–Interpolations
- Newton's interpolation and Lagrange's interpolation, Curve fitting – Method of Least squares.Numerical differentiation and integration – Trapezoidal rule and Simpson's 1/3 rule – Solutionsofdifferential equations– Euler'smethod and Runga-kuttaMethods.

UNIT–IV:ComplexVariables

Functions–Complexdifferentiation-Analyticfunction-Cauchy–Riemannequations –Derivatives of elementary functions – Singular points and classification. Complex integration -Cauchy's theorem – Integrals of special functions – Cauchy's integral formula – Taylor's andLorentz theorem (statements only) – Residues, calculations of residues - Residue theorem –evaluationof definite integrals.

BooksforStudy

1. Mathematicalphysics,B.D.Gupta,4th edition,Vikaspublishinghouse,2010
2. Mathematical physics,B.S.Rajput,PragatiPrakashanMeerut,2017
3. SpecialFunctionsforScientistsandEngineers,W.W.Bell,DoverPublications,2013
4. LaplaceTransforms,MurraySpiegle,Schaum'soutlineseries,McGrawHill,InternationalBookCompany,NY, 2005
5. AppliedMathematicsforEngineers,LouisA.Pipes,LawrenceR.Harvill,CourierCorporation,2014
6. TheoryandPropertiesofComplexVariables,Schaum'soutlineseries,MurrayR.Spiegel,SeymourLipschutz,JohnJ.Schiller, DennisSpellman, McGraw-Hill, 1976
7. ComplexVariablesandApplications,BrownandChurchill,McGraw–Hill,2013
8. AppliedFourieranalysis,HweipiaoHsu, UnitechDivision,1984
9. AnIntroductiontoMathematicalPhysics,SureshChandra,MohitKumarSarmaAlphaScienceInternational,2013.

(ElectiveFoundation)

PHY204(b)	**Introduction to VLSI design**	**L-5,T-1,P-0**	**4Credits**
Pre-requisite:Understandingofgraduatelevelmathematics			
Course Objectives: The aim and objective of the course on is to equiptheM.Sc.Studentswiththe**Introduction to VLSI design** thathe/sheneedsforunderstandingtheoreticaltreatmentindifferentcoursestaughtinthisclassandfordevelopingastrongbackgroundif he/she chooses to pursueresearch inphysics asacareer.			
CourseOutcomes: At theend ofthecourse,the studentwillable to			
CO1	Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.		
CO2	Analyze CMOS based logic circuit		
CO3	Realize logic circuits with different design styles		
CO4	Understand Front & Back end design aspects of simple VLSI Digital circuits		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	1	-	2	1	-	-
CO2	3	3	2	2	2	1	1	-	2	1	-	-
CO3	3	3	2	2	2	1	1	-	2	1	-	-
CO4	3	3	2	2	2	1	1	-	2	1	-	-

PHY 204 (b): Introduction to VLSI Design

UNIT-I:**AnOverview of VLSIandLogicDesignwithMOSFET**

Complexity and Design, Basic concepts, Ideal switches and Boolean operations, MOSFETs asswitches, Basic logicsgates in CMOS,Complexlogicgates in CMOS, Transmission Gatecircuits,Clockingand data flowcontrol.

UNIT-II: PhysicalStructureandFabricationof CMOS ICs

Integrated Circuit layers, MOSFETs, CMOS layers, Designing FET arrays, Overview of siliconprocessing, Material growth and deposition,Lithography, The CMOSprocess flow, Designrules.

UNIT-III:**ElementsofPhysicalDesign andElectricalCharacteristicsofMOSFETs**

Basic concepts, Layout of basic structures, Cell concepts, FET sizing and the unit transistor,Physicaldesignoflogicgates,Designhierarchies,MOSphysics,nFETcurrent-voltageequations,FET RC model,pFET characteristics,Modelingofsmall MOSFETs.

UNIT-IV:**Electronicanalysisof CMOSlogicgates**

DC characteristics of the CMOS inverter, Inverter switching characteristics, Power dissipation,DC characteristics: NAND and NOR gates, NAND and NOR transient response, Analysis ofcomplexlogicgates,Gatedesignfortransientperformance,Transmissiongatesandpasstransistors.

Designing High-speed CMOS Logic Networks- Gate delays, Driving Large capacitive loads,Logicaleffort, BiCMOS drivers.

BookforStudy

1. JohnP. Uyemura,"Introduction toVLSIcircuitsand Systems",John Wiley&SonsAsia)PetLtd., 2003.
2. S.K.Ghandhi,"VLSIFabricationprinciples",2/e,JohnWiley&Sons(Asia)Pte.Ltd.,2003.
3. S.M.Sze,"VLSITechnology",2/e,McGraw-Hill,1988.
4. N.H.E.WesteandK.Eshraghian,"PrinciplesofCMOSVLSIdesign",PearsonEducation,Inc., 1999.
5. YuanTaurandT.H.Ning,"FundamentalsofModernVLSIdevices",CambridgeUniversity,Press, 1998.
6. R.L.Geiger,P.E.AllenandN.R.Strader,"VLSIdesignTechniquesforAnalogandDigitalCircuits", McGraw-Hill, 1990.

(ElectiveFoundation)

PHY -204 (c)	Materials Science for Industrial Applications	L-5,T-1,P-0	4Credits
Pre-requisite: CourseonParticlePhysics			
CourseObjectives: TheaimandobjectiveofthecourseonMaterials Science for Industrial Applicationsis to expose the students of M.Sc. students to experimental aspectsofdifferent equipment andmethods used inthe fields ofIndustrial applications			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	Understandvariousexperimentaltechniquesfordescribinginteractionoforg anic materials		
CO2	Useerroranalysisforexperimentaldata.		
CO3	KnowledgeaboutthedifferenttypesoftheLiquid crystals		
CO4	Applytheknowledgeof phase transformations forvarious applications		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	-	-	-	-	1	1	-
CO2	3	2	2	3	2	-	-	-	1	-	1	-
CO3	3	2	1	2	3	-	1	-	2	2	-	-
CO4	3	2	1	3	3	1	1	-	2	-	2	-

PHY 204 (c): Materials Science for Industrial

ApplicationsUNIT– I:Organicmaterials and theirproperties

Introduction - polymerization mechanism. Structure and properties of polymers.Strengthening ofpolymers.Behaviorof polymers.Deformationofpolymersand theirindustrial use.CeramicMaterials:Introduction–Classificationofceramic.Structureofceramics.Polymorphism.Propertiesof ceramicand their applications.

UNIT–II:LiquidCrystals

Introduction–classification,orientalorder,Elasticity,magneticeffects,opticalproperties – applications.
Ferroelectrics:Generalpropertiesofferroelectricmaterials.Theoriesofferroelectricity.ThermodynamicofFerroelectrictransitions.MagneticMaterials:Classification.Thedomainstructure.Softandhardmagneticmaterials,Ferrites,ceramicmagnets.

UNIT–III:Phasediagramsandphasetransformation

The Phase rules.Unary and binary phase diagrams.Typical phase diagrams- coper-zincsystems.Iron-carbon system.Other applications of phase diagrams.Phase transformation.Nucleationandgrowth.Nucleation kinetics.Martensictransformation.

UNIT–IV:Thin films

Theories of thin film nucleation and growth.Thin film preparation – Rf sputtering.Chemicalvapordeposition.Thickensmeasurements.Electricalandopticalpropertiesof thinfilmsApplications.
Superconductivity:MessierEffect.Thecriticalfield.Theoriesofsuperconductivity.Tunnelingand Josephsoneffect.HighTcsuperconductors.Applicationofsuperconductors.

BooksforStudy

1. IntroductiontoSolid StatePhysics, CharlesKittel VIIedition,John Wiley&Sons.
2. SolidStatePhysics,A.J.Dekker,McMillanPublications.
3. SolidStatePhysics,M.A.Wahab,NarosaPublishingHouse.
4. FundamentalsofSolidStatePhysics,Saxena,Gupta,Saxena,PragathiPublications,Meerut.
5. SolidStatePhysics,R.L.Singhal,KedarNath RamNath&Co.Pub.
6. ScienceofEngineeringMaterials,C.M.SrivastsavaandC.Srinivasan,NewAgeInter.Pub.
7. CrystalGrowth,B.R.Pamplin,PergmonPress.
8. Crystal Growth from High Temperature Solutions, D. Elwell and H.J. Scheel, AcademicPress.

(MandatoryCore)

PHY-301	Introductory QuantumMechanics	L-5,T-1,P-0	4Credits
Pre-requisite: Basicknowledgeofwavemechanicalquantum Mechanics			
Course Objectives: The aim and objective of the course on **IntroductoryQuantum Mechanics** is to introducethe students of M.Sc. class to the formal structure of the subject and to equip them with thetechniques of vector spaces, angular momentum, perturbation theory, and scattering theory so thattheycan usethesein various branches of physicsas per their requirement.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	Understandtheneedfor quantummechanicalformalism anditsbasicprinciples.		
CO2	Appreciatetheimportanceandimplicationofvectorspaces,DiracKetBranotations,eigen value problem.		
CO3	Understandthe need of approximate methods in solving problems		
CO4	Understanding scattering theory and its importance.		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	2	1	-	2	1	-	-
CO2	3	2	2	2	2	2	1	-	-	2	2	-
CO3	3	2	2	2	2	2	1	-	-	-	-	-
CO4	3	2	2	2	2	2	2	-	2	2	-	1

PHY 301: IntroductoryQuantumMechanics

UNIT-I: Formulationand SimpleProblems

Wave particle duality – Wave functions in coordinate and momentum representation-Postulatesof quantum mechanics -Linear vector space: Hilbert space - Dirac's Bra and Ket notations-Hermitianoperatorsandtheirproperties-Matrixrepresentationofanoperator-Unitaryoperators- Unitary transformation - The Kronicker Delta and Dirac delta functions-Eigen valuesandEigenfunctionsforfinite potentialwellandstep barrier–Quantummechanicaltunneling.

UNIT-II:QuantumDynamicsand SimpleProblems

Equations of motion - Schrodinger Picture- Heisenberg Picture- Interaction Picture-EquivalenceofvariousPictures-PoissonandCommutationbrackets-TheirProperties-EigenvaluesandEigenfunctionsforSimpleharmonicoscillator-Polynomialmethodandabstractoperatormethod in one dimension- Eigen values and Eigen functions for a free particle and particle in aboxin threedimensions.

(MandatoryCore)

UNIT-III:ApproximateMethods

Time independent perturbation theory for non-degenerate levels: Perturbed harmonic oscillator,NormalHeliumatom,Starkeffectoftheplanerotator.Firstorderperturbationtheoryford egenerate levels: First order Stark effecting in hydrogen atom; Time dependent perturbationtheory:Transition to continuum (Fermi Golden rule).
WKB approximation – Turning points and connecting formulae: Application to potential barrier.Variationalmethods.

UNIT-IV:ScatteringTheory

Introduction: classical theory of scattering - Quantum theory of scattering - Method of partialwaveanalysis- Scattering by a perfectly rigidsphere- Greensfunctioninscattering theory -Bornapproximation-ValidityofBorn approximation-optical theorem.

BooksforStudy

1. QuantumMechanics:ConceptsandApplicationsbyNouredineZettili,Wiley,Ed.,2021
2. IntroductiontoQuantumMechanicsbyDavidJ.GriffithsandDarrellF.Schoeter,ThirdEd.,Cambri dgeUniversityPress India PvtLtd.,2018.
3. QuantumMechanics: G. AruldasPHIlearningprivatelimitedSecondedition,2018
4. QuantumMechanics:S.L.KakaniandH.M.ChandaliaSultanChandand,SonsFirstEdition,2004
5. AdvancedQuantumMechanics: B.S.Rajput,Pragatiprakasan,2019
6. QuantumMechanics:V.K.Thankappan, NewAgeInternational(P)Ltd.,Publishers,1993
7. ATextbookofQuantumMechanics:P.M.MathewsandK.Venkatesan,TataMcGrawHillPublishin gCompany, 2008
8. QuantumMechanics:S.L.Gupta,V.Kumar,H.V.SharmaandR.C.Sharma,JaiPrakashNathandCo mpany, 2007
9. An Introduction toQuantum Mechanics,P.T. MathewsMcGrawHillPublishingCompany,1974

(MandatoryCore)

PHY -302	Physics of Semiconductor devices	L-5,T-1,P-0	4Credits
Pre-requisite: CourseongeneralPhysics			
CourseObjectives: Theaimandobjectiveofthecourseon**Physics of Semiconductor devices**is to expose the students of M.Sc. students to experimental aspectsofdifferent semiconductor devise technologies, characterization and fabrication.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	Understandvariousexperimentaltechniquesforsemiconductor junctions and interfaces		
CO2	UseI-V characteristics to understand the function of devices		
CO3	Apply the knowledge of Junction transistors for various applications		
CO4	To get familiarization with Power Devices and Semiconductor Technology		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	2	2	-	1	1	1	-
CO2	3	2	1	3	2	1	-	-	1	1	-	1
CO3	3	2	1	2	3	2	1	-	2	2	-	-
CO4	3	2	1	3	3	1	1	-	-	2	2	2

PHY302:PhysicsofSemiconductorDevic

esUNIT-I: Junctions and Interfaces

p-nJunctions:Descriptionofp-nJunctionaction–Junctioninequilibrium-applicationofbias– energy band diagrams.Abrupt junction – calculation of the built-in Voltage- electric field andpotential distributions – Expression for Depletion layer capacitance, Static I-V characteristics ofp-n junction diodes: Ideal diode model- Derivation of ideal diode equation. Real diodes –Carrier generation – recombination in the junction depletion region, I-V characteristics of RealDiodes.
Electricalbreakdowninp-njunctions:ZenerandAvalanchebreakdowninp-njunctions,Distinctionbetween theZenerand Avalanchebreakdown.

UNIT-II:JunctionDiodes

Majority carrier diodes: Tunnel diode- I-V characteristics, equivalent circuits as an oscillator andamplifier.Backward diode, Schottkybarrierdiode-operation and applications.
Microwave devices:Varactor diode- basic principle, equivalent circuit,Figure of merit andapplications.p-i-ndiodeoperationanditsapplications.Transferred-electrondevices-Gunneffect devices- domain formation- modes of operation. Avalanche Transit devices: IMPATTdiode,TRAPATT diode, BARITT diode.

UNIT-III:JunctionTransistors

Bipolar junction transistors: Principle of operation- Analysis of the ideal diffusion transistor –Calculationofterminalcurrents,DCparameters.Ebers-MollEquations–Fourregionsofoperation of a bipolar transistor. Real transistors -- carrier recombination in the Emitter-Basejunction depletion region – Effect of collector bias variation, avalanche multiplication in thecollector – base junction and base resistance. Basic Structures and the operating principle ofMOSFET,I-VcharacteristicsofanidealMOSFET,ChargeCoupledDevices(CCD)-principleofoperation.

UNIT–IV: PowerDevicesandSemiconductorTechnology

Power rectifiers and Thyristors:Power rectifiers, Thyristors, Some special thyristor structures,Bidirectionalthyristors,Field-controlledthyristor.TechnologyofSemiconductorDevices:CrystalgrowthandWaferpreparation ,Methodsofp-njunctionformation,Growthanddeposition of dielectric layers, Planar technology, Masking and lithography, Pattern definition,Metaldeposition techniques.

BooksforStudy

1. IntroductiontoSemiconductorMaterialsandDevicesbyM.S.Tyagi,JohnWiley&Sons(Asia)Pte.Ltd., Singapore, 2000.
2. MicrowaveDevicesandcircuitsbySAMUELY. LIAO,Prentice-HallofIndia,1999.
3. MicrowaveandRadarEngineeringbyM.Kulkarni,UMESHpublications,NewDelhi,1999.
4. PhysicsofSemiconductor Devices byS.M.Sze, 3rd Edition, Oct.2006,JohnWiley
5. SolidStateElectronicDevices byB.G. Streetman,PHI, NewDelhi, 2006

(GenericElective)

PHY-303 (a)	AppliedSpectroscopy	L-3,T-1,P-2	4Credits
Pre-requisite: Understandingof graduatelevelspectroscopy			
Course Objectives: The aim and objective of the course on AppliedSpectroscopy ForthestudentsofM.Sc.Physicsistoequipthemwiththeknowledgeof Atomic,Rotational,Vibrational,Raman, andElectronicspectra.			
CourseOutcomes: At theend ofthecourse, thestudent willbeableto			
CO1	Understand the rotational and vibrational spectra of dimolecules and their applications in structure determinations.		
CO2	Know the Raman effect and its use in the structural analysis of various molecules.		
CO3	Have the knowledge about various spectrophotometer and the functioning of various parts in SPECTROPHOTOMETER.		
CO4	Understand the basic concepts of fluorescence and phosphorescence their applications in different fields		

Mappingof courseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	1	1	-	2	1	-	-
CO2	3	2	3	3	-	1	2	-	2	1	-	-
CO3	3	2	3	3	2	-	2	-	2	1	-	-
CO4	3	2	3	3	-	-	2	-	2	1	-	-

PHY303(a):AppliedSpectroscopy

UNIT-I:MolecularSpectroscopy

Introduction – Rotational and vibrational structure of electronic bands of diatomic molecules –Fortrat diagram – General relations – Combination relations for $^1\Sigma$- $^1\Sigma$ and $^1\Sigma$ – $^1\pi$ bands – Evaluation of rotational constants with reference to above transitions. Isotope effect in electronicspectra of diatomic molecules – Vibrational effect and rotational effect. Potential energy curves -Dissociation energy and pre-dissociation energy - Vibrations of polyatomic molecules: CO_2 andH_2O.

UNIT-II:RamanSpectroscopy

Introduction – Theory of Raman Scattering – Rotational Raman Spectra – Vibrational RamanSpectra– MutualExclusionPrincipleLaserRamanSpectroscopySampleHandlingTechniques – Polarization of Raman Scattered Light – Single Crystal Raman Spectra – RamanInvestigation of Phase Transitions – Resonance Raman Scattering – Structure Determinationusing FTIR and Raman Spectroscopy.Fourier Transform (FT) Raman Spectroscopy and itsadditional advantages over the conventional Raman Spectroscopy - Surface enhanced RamanScattering-CoherentAnti-Stokes Raman Spectroscopy.

UNIT–III:Spectrophotometry

Introduction – Beer’s law – Absorptivity – UV and visible absorption –Instrumentation –

(GenericElective)

Essential parts of spectrophotometer – Gratings and prisms – Radiant energy sources – Filters –Photosensitive detectors – Barrier layer cells – Photo emissive cells – Photomultiplier tubes –Relationship between absorption in the visible and UV region and molecular structure – IRSpectrophotometry – Fourier Transform Infrared (FTIR) Spectrometer – Molecular structure –QualitativeandQuantitativeanalysis– Importanceofphotographyinthespectrochemicalanalysis.

UNIT-IV:FluorescenceandPhosphorescenceSpectroscopy

Introduction – Normal and Resonance Fluorescence – Intensities of Transitions – Non-radiativedecay of fluorescent molecules – Phosphorescence and the nature of the triplet state – Populationof the tripletstate–DelayedFluorescence–Excitationspectra–Experimentalmethods–Emissionlifetimemeasurements–Timeresolvedemissionspectroscopy–ApplicationsofFluorescenceand Phosphorescence.

BooksforStudy

1. Molecularspectra andMolecular StructureVol.I, G. Herzberg,2nd Ed,Van. Nostrand(1950).
2. FundamentalsofMolecularSpectroscopy,C.N.Banwell,TataMcGraw-Hill,(1983).
3. SpectroscopyStraughan andWalker(Vol.2 &3),John Wiley&Sons, (1976).
4. MolecularStructureandSpectroscopyG.Aruldhas,Printice-Hall Pvt.Ltd.(2001).
5. InstrumentalMethodsofAnalysisWillard,Merritt,Dean&Settle,CBSPub,(2001).
6. SpectrochemicalAnalysis,L.H.AhrensandS.R.Taylor,Addison–Wesley,London,Pergamon,1961.
7. ElementsofSpectroscopy,Gupta,Kumar andSharmaPragatiPrakasan,NewDelhi (2012).
8. ElementsofDiatomicMolecularSpectra,H.Dunford,AddisonWeslyPublishingcompany,1965.
9. ProblemsinSpectroscopy,S.V.J.Lakshman,ICSU,Costed,1988.
10. BasicPrinciplesofSpectroscopybyR.Chang, MicGraw Hill,1971.
11. PrinciplesofFluorescenceSpectroscopy, JosephR.Lakowicz-PlenumPress, (1983).

(GenericElective)

PHY-303(b)	CondensedMatterPhysics	L-3,T-1,P-2	4Credits

Pre-requisite: Understandingofgraduatelevelsolidstatephysics

Course Objectives: The aim and objective of the course on **Condensed Matter Physics** is toexpose the students of M.Sc.class to the topics like elastic properties, thermal properties, Fermi surface studies and photoluminescence so that they are equipped with the knowledge on thematterincondensedphase.

CourseOutcomes: At theend ofthe course, thestudent willbe ableto

CO1	They gain knowledge on elastic properties of solids and its importance.
CO2	Differentiate they gain knowledge on specific heat and Thermal importance.
CO3	Understand the importance of Fermisurface in electrical properties of Solids.
CO4	Gain knowledge on photoconductivity and its origin

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	2	1	-	-	2	-	-
CO2	3	2	2	2	2	2	2	-	2	-	2	-
CO3	3	2	2	2	1	2	2	-	-	2	-	-
CO4	3	2	2	2	2	2	1	-	1	-	2	-

PHY303(b):CondensedMatterPhysi

csUNIT-I: ElasticProperties ofSolids

Lattice as a homogeneous and continuous medium - Analysis of stress and strain tensors – Hooke's law - Elastic compliances and stiffnessconstants– Elastic energy density – Reductioninthenumberindependentelasticconstantsincubiccrystals–Cauchy'srelations– Bulkmodulus and compressibility – Elastic waves in cubic crystals – Formulation and solution ofwave equations along [100], [110] and [111] directions – Experimental determination of elasticconstants – Pulse-echo technique.

UNIT-II:Thermal Propertiesof Solids

Quantum theory of lattice vibrations – Properties of phonons – Lattice specific heat at lowtemperatures – Einstein and Debye models – Born cut-off procedure – Inelastic scattering ofneutronsbyphonons–Experimentalstudyofdispersioncurves– Inadequacyofharmonic model
– Anharmonicity – Thermal expansion – Gruneisen parameter- Lattice thermal conductivity –Elementarykinetic theory– Role ofUand N processes.

UNIT-III:EnergybandsandFermiSurfaces

Energy band calculations: Plane Wave method and Augmented Plane Wave (APW) method.Importance of Fermi surface – Characteristics of Fermi surface – Construction of

(GenericElective)

Fermi surface -Quantization of electron orbits - Experimental study of Fermi surface:Anomalousskin effect –Cyclotronresonance – deHaas vanAlphen effect.

UNIT-IV:PhotoconductivityandLuminescence

Excitons: Weakly bound and tightly bound – Photoconductivity – Simple model – Influence oftraps – Space charge effects – Determination of photoconductivity. Luminescence – Varioustypes– Thermoluminescence,Electroluminescence,Photoluminescence,CathodoluminescenceandChemiluminescence-Excitation andemission–Decaymechanisms –Applications

BooksforStudy

1. SolidStatePhysics, C. Kittel, Edition:8th 2012,John Wiley&Sons.
2. SolidStatePhysics,A.J.Dekkar,Edition:1st,2000. Macmillan IndiaLtd.
3. SolidStatePhysics,M.A.Wahab,Edition:3rd,2020,NarosaPublishingHouse.
4. Fundamentals of Solid State Physics, Saxena, Gupta, Saxena, Edition: 31st, 2019,Pragathi
5. SolidStatePhysics,R.L. Singhal,KedarNath,RamNath&Co.Publications,Meerut,2018.

(GenericElective)

PHY-303 (c)	EmbeddedSystems	L-3,T-1,P-2	4Credits
Pre-requisite: Understandingof graduatelevelspectroscopy			
Course Objectives: The aim and objective of the course on EmbeddedSystems forthestudentsof M.Sc.Physicsistoequipthemwiththeknowledgeof microcontrollers and other processors used in the industry.			
CourseOutcomes: At theend ofthecourse, thestudent willbe ableto			
CO1	understand about the basic functions and structure of embedded systems		
CO2	Get familiarized with Embedded system Design Tools and Hardware		
CO3	understand about the basic programming concepts of embedded systems		
CO4	know about the applications of PIC microcontrollers		

Mappingof courseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	1	-	-	2	1	1	-
CO2	3	2	3	3	2	1	2	-	2	-	1	-
CO3	3	2	3	3	2	-	-	-	2	1	1	-
CO4	3	2	3	3	2	1	2	-	2	1	1	-

PHY303(c):EmbeddedSyste

msUNIT-I:IntroductiontoEmbedded Systems

Embedded systems in today's world – examples of Embedded systems – Microprocessors andMicrocontrollers – Microchip and PIC microcontroller – Introduction to PIC microcontrollersusingthe 12 series.
Architecture of 16F84A – Memory organization – in 16F84A – Timing generation – Power-upandReset functions in 16F84A.

UNIT-II:HardwareDetailsof 16F84A

Parallel ports: Basic idea – Technical challenge – connecting to the parallel port – Parallel portsof PIC16F84A – Clock oscillator – Power supply – Interrupts – Timers and counters – watch dogtimer– Sleep mode.

UNIT-III:AssemblerandAssemblerPrograms

Basic idea – PIC 16 series instruction set and ALU – Assemblers and Assembler format –

creatingsimpleprograms–Adoptingadevelopmentenvironment–Buildingstructuredprograms – Flow control: Branching and Subroutines – Generating time delays and intervals – Logicalinstruction– Arithmetic instructions.

UNIT-IV:PICMicrocontrollerPIC16F873A

BlockdiagramandCPU–Memoryand memorymaps–Interrupts–Oscillator,ResetandPowersupply– Parallel ports.PIC16F87XATimer0andTimer1–16F87XATimer2,ComparatorandPR2register–capture/Compare/PWM(CCP) Module–Pulse width modulation–ADC module.
Interface:LEDdisplays– Liquidcrystaldisplays–Sensors–Actuators.

BooksforStudy

1. DesigningEmbeddedSystemswithPICMicrocontrollers:PrinciplesandApplicationsbyTimWilmshurst, First Edition, 2007, Newnes– Elsevier– Publishers.
2. Microcontrollers: Theory and Applications by Ajay V. Deshmukh, Tata McGraw-Hill,NewDelhi, 2005.
3. DesigningwithPICMicrocontrollers byJohnB.Peatman, PearsonEducation,Inc.,1998.
4. The8051MicrocontrollerandEmbeddedsystems,byMahammadAliMazidiandJaniceGillispieMazidi,Pearson Education Asia, Pvt.Ltd.,2000.

(SkillOrientedCourse)

PHY – 305	Advances in Physics	L-3,T-1,P-2	4Credits

Pre-requisite: Understandingof graduatelevelphysics

Course Objectives: The aim and objective of the course on **Advances Physics** forthestudentsofM.Sc.Physicsistoequipthemwiththeknowledgeof Nanotechnology, MEMS and remote sensing.

CourseOutcomes: At theend ofthecourse, thestudent willbe ableto

CO1	Understand the concepts of nanotechnology
CO2	Physical and chemical techniques of nanomaterial synthesis
CO3	Concepts of Nano materials and Nano devices
CO4	Basics of remote sensing and understanding the concepts of Geographical Information system

Mappingof courseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	-	1	-	-	2	2	-	-
CO2	3	2	3	3	2	1	2	-	2	2	-	-
CO3	3	2	3	3	-	1	-	-	2	2	-	-
CO4	3	2	3	-	2	1	2	-	2	2	-	-

PHY305:Advancesin Physics

UNIT–I:NanoTechnology

IntroductiontoNanomaterials–Zero,One- and Two-DimensionalNanostructures-Quantumconfinement-DensityofstatesandDependenceofdimensionality–Propertiesof Nanomaterials –CarbonNanotubes, Fullerenes,Graphene.

Synthesis ofNanomaterials–PhysicalTechniques: BallMilling–PlasmaArcDeposition–InertGasCondensation –PulsedLaser Deposition– MolecularBeam Epitaxy.

Chemical Techniques:Hydrothermalsynthesis– Sol-GelProcess–ChemicalVaporDeposition.Applications:Single Electron Transistor – SolarCells–Light EmittingDiodes.

UNIT–II:MicroandNanodevices

Microelectromechanicalsystems(MEMS):IntroductiontoMEMS,BasicMEMstructure.Applicationsof MEMS: Pressuresensors, AccelerometersMass flow sensors.

Nanodevices:Quantumwellandquantumdotdevices:InfraredDetectors-QuantumDotLasers.Carbonnanotubeemitters-Photoelectrical cells - Plasmons propagationin wave guides.

UNIT–III:8051Microcontrollers

IntroductionofMicroprocessorsandMicrocontrollers,Microcontroller:8051InternalArchitecture, Register Structure, I/O pins, Memory Organization, 8051 Addressing modes. 8051AssemblyLanguageProgrammingTools.8051Instructionset:DataTransferInstructions,Arithmetic instructions, Logical instructions, Boolean Variable Manipulation Instructions-BitAddressability, Single-Bit instructions, Program Branching Instructions-Jump, Loop, and Callinstructions,RotateInstructions, Stack Pointer.

UNIT -IV:RemoteSensing

Definition of remote sensing; introduction to concepts and systems; Electromagnetic radiation;electromagneticspectrum;imagecharacteristics;remotesensingsystems;remotesensingplatform; Sources of remote sensing information; Advantages of remote sensing. Application ofRemotesensinginEnvironmentalManagement,Naturalresourcemanagement–forestresources,water resources, land resourcesand mineral resources.

BooksforStudy

1. Nano structures and Nanomaterials: Synthesis, Properties and Application byGuozliongCa
2. IntroductiontoNanotechnology,ByCharlesP.Poole,Jr andFrankJ.Owens,WilleyIndia(2006).
3. AnIntroductiontoMicroelectromechanicalSystemsEngineeringbyNadimMaluf,ArtechHousePublishers, 2004
4. NanomaterialsSynthesisPropertiesandApplications,byAlen.S.EdelsteinandRobertC.Cammarata, 1998.
5. The8051MicrocontrollerandEmbeddedsystems,byMahammadAliMazidiandJaniceGillispieMazidi,Pearson Education Asia, Pvt.Ltd.,2000.
6. FloydF.SabinsJr.,RemoteSensingPrinciplesandinterpretation,byW.H.FreemanandCompany, 2nd Ed., New York, 1987.
7. T.M.Lillesand&R.W.Kiefer,RemoteSensingandImageInterpretation',byJohnWiley&Sons, New York, 1994.
8. AnIntroductiontoGISbyIanHeywoodetal.,AddisionWesley,LongmontLimited,England, 2011.

(OpenElective)

PHY – 306 (a)	Basic Spectroscopic Techniques	L-3,T-1,P-2	4Credits
Pre-requisite: Understandingofgraduatelevelspectroscopy			
Course Objectives: The aim and objective of the course on **Basic Spectroscopic Techniques**forthestudentsofM.Sc.Physicsistoequipthemwiththeknowledgeof Atomic,Rotational,Vibrational,Raman, andElectronicspectra.			
CourseOutcomes: At theend ofthecourse, thestudent willbe ableto			
CO1	HavethebasicknowledgeofBohr's-SommerfieldQuantumtheoryofhydrogenlikeatom		
CO2	Understandclassical/quantumdescriptionofelectronicspectraofatomandmolecules		
CO3	UsemicrowaveandRaman Spectroscopyforanalysis ofknown molecules		
CO4	Correlateinfraredspectroscopicinformationofknownmoleculeswiththeirphysicaldescription		

Mappingof courseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	1	1	-	2	1	-	
CO2	3	2	3	3	2	1	2	-	2	1	1	-
CO3	3	2	3	3	2	1	2	-	2	1	-	-
CO4	3	2	-	3	2	1	2	-	2	1	-	-

PHY 306 (a): Basic Spectroscopic Techniques

UNITI:Fundamentalsof Spectroscopy

Introduction - Interaction of Electromagnetic radiation with matter - Spectra of Hydrogen atom-quantumnumbers -Forbidden transitions and selection rules- Spectroscopic transition between two stationarystates - Absorption and emission of a photon - Einstein A and B coefficients - Line shape functions -Spectralbroadeningmechanisms-Spinorbitinteractionenergy-Stern-Gerlachexperiment-LScoupling– JJ coupling – Hund's rule of multiplicity - Pauli'sexclusion principle - Rotational and vibrationalspectraof differentmolecules-Energyexpressions.

UNIT– II:Spectrophotometry

Introduction – Beer's law – Absorptivity – UV and visible absorption –Instrumentation – Essential partsofspectrophotometer–Gratingsandprisms–Radiantenergysources–Filters–Photosensitivedetectors – Barrier layer cells – Photo emissive cells – Photomultiplier tubes – Relationship between absorption inthe visible and UV region and molecular structure – IR Spectrophotometry – Fourier Transform Infrared(FTIR)Spectrometer–Molecularstructure–QualitativeandQuantitativeanalysis–Importanceofphotographyinthespectrochemicalanalysis.

UNIT–III:Colorimeters,spectrophotometersandmicroscopes

Colorimeter – Principle - Applications of colorimeters in analytical and biomedical purposesSpectrophotometer-Principleandworkingwithblockdiagram–Salientfeaturesofindividualblocks–Specificationsandoperationofspectrophotometers–Applicationsofspectrophotometerstochemicalanalysis Electron microscope – Transmission electron microscope - Principle and working with block diagram –Salient features of individual blocks – Scanning electron microscope - Principle and working with blockdiagram– Descriptionofindividual blocks– Applications ofelectronmicroscopes.

UNIT–IV:ResonancespectrometersandMassSpectrometer

Electronspinresonance–theory–ESRspectrometer–Principleandworkingwithblockdiagram–Experimentaltechniques–Salientfeaturesofindividual blocks– ApplicationsofESR.
Nuclearmagneticresonance–theory–NMRspectrometer-Principleandworkingwithblockdiagram–Experimentaltechniques–Descriptionofindividualblocks– Applicationsof NMR.
Mossbauereffect–theory–Mossbauerspectrometer–PrincipleandworkingofMossbauerspectrometer -Experimental methods–Explanationof blockdiagram– ApplicationsofMossbauerstudies.

BooksforStudy

1. IntroductiontoAtomicSpectra,H.E.White,McGraw-HillKogakusha.Ltd.,NewDelhi(1934).
2. Elementsof SpectroscopybyGupta,Kumar, Sarma,Pragati Prakasan,2012.
3. Spectrochemical Analysis,L. H. Ahrensand S.R.Tayler, Addison-Wesley, London, 1961.
4. InstrumentalmethodsofChemical analysisbyChatwalandAnand,HimalayaPublisher,2003
5. SpectroscopybyB.K.Sarma, GoelpublishingHouse,Meerut,1993.
6. SpectroscopyVolIbyStraughan andWalker,JohnWileyand Sons,1976
7. BasicprinciplesofSpectroscopybyRaymondChang,MicGrawHill,1971
8. MolecularStructureandSpectroscopybyG.Aruldas,PrenticeHall ofIndia,2001

(OpenElective)

PHY-306(a)	Nanomaterials and Devices	L-5,T-1,P-0	4Credits
Pre-requisite: Condensedmatterphysics			
Course Objectives: The aim and objective of the course on **Physics of Nano-materials** is tofamiliarize the students of M.Sc. to the various aspects related to preparation, characterization andstudyofdifferentpropertiesofnanomaterialssothattheycanpursuethisemergingresearchfieldascareer.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	Understanding the basics of nanomaterials		
CO2	Acquireknowledgeofbasicapproachesto synthesize thenanaomaterials		
CO3	Understand the physical and chemical properties of carbon nano tubes and nano structured materials.		
CO4	Introduction to nanodevices		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	1	2	-	1	2	1	-
CO2	3	2	2	2	3	2	2	-	1	2	-	-
CO3	3	3	-	2	3	2	2	-	1	2	1	-
CO4	3	2	3	2	3	2	2	-	1	2	-	-

PHY 306 (b): Nanomaterials and Devices

UNIT-1:Introduction to Nanomaterials

IntroductiontoNanomaterials-Zero,OneandTwoDimensionalNanomaterialsQuantumconfinement,Densityofstates,Dependenceofdimensionality–Physicalandchemicalproperties.

UNIT–II:SynthesisofNanomaterials

IntroductiontoBottom –upandTop-downapproaches

Ball milling –Inert Gas condensation – Physical vapor deposition -, Molecular Beam Epitaxy –Sputtering – Pulsed laser Deposition –Chemical vapor deposition - Sol Gel – HydrothermalSynthesis

UNIT-III: Nano –Carbon

Carbon molecules: Nature of the carbon bond –New Carbon structure –carbon clusters – Smallcarbon clusters –Discovery of C_{60}–Structure of $C_{60}$and its properties –Synthesis of buckyballsandApplications.

Carbon Nanotubes: Fabrication –Structure -Electrical Properties – Mechanical properties – Applicationsof carbonNanotubes

Graphene:Fabrication–Structure–ElectricalProperties–Mechanicalproperties–Applications.

UNIT–IV:NanoDevices

Introduction–Nanofabrication–Photo-Lithography–Patterntransfer–IntroductiontoMEMS –SingleElectronTransistor–SolarCells–LightEmittingdiodes–GasSensors-Microbatteries –Fieldemissiondisplaydevices –FuelCells.

BooksforStudy

1. Nanomaterials:Synthesis,opertiesandApplications–EditedbyA.S.EdelsteinandR.C.Cammarata, InstituteofPhysics Publishing, 2002.
2. IntroudctiontoNanotechnology–CharlesP.PooleJrandFrantJ.Owens,WileyInterscience,2003.
3. Nano practices from Theroyto Applications edited byGunter Schmid, WileyVCH, 2004.
4. Nanoelectronicsand Nanosystems byK. Glosekotterand J. Dienstuthi (Springer), 2004.

(MandatoryCore)

PHY-401:AdvancedQuantumMechanics

PHY- 401	Advanced QuantumMechanics	L-5 T-1 P-0	4Credits
Pre-requisite: PreliminarycourseofQuantumMechanics			
CourseObjectives: Theaimandobjectiveofthecourseon**AdvancedQuantumMechanics**is tointroduce the M.Sc. students to the formal structure of the subject and to equip him/her with the concept of identical particles, angular momentum. Relativistic quantum mechanics and Quantum field theory so that he/she can usethesein various branchesof physicsas per his/herrequirement.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			

CO1	Understand the concept of identifiable particles
CO2	Understand the Orbital Angular momentum spin angular momentum and general angular momentum and their importance in spectroscopy
CO3	Give the significance of Klein Gordon and Dirac equation and explain the existence of antiparticles.
CO4	Apply the symmetries principles in calculating the conserved currents and charges.

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	1	1	1	-	2	1	2	-
CO2	3	2	3	-	1	1	1	-	2	1	2	-
CO3	3	2	2	2	1	1	1	-	2	1	2	-
CO4	3	3	2	2	1	1	1	-	2	1	2	-

PHY- 401: Advanced Quantum Mechanics

UNIT-I:Identical ParticlesandMolecules

Identical particles- Indistinguishability of Identical particles- Construction of Symmetric andAnti-symmetric wave functions for two and three particle systems - Pauli's Exclusion Principle-Hydrogenmolecule-Spin-orbitinteraction-OrthoandParahydrogen-Spinstatisticsconnection.

UNIT-II:Angular Momentum

Introduction: Motion in Central Potential, Orbital Angular momentum –L_x, L_y,L_z,L_2,L^+ and L^-Operators -Commutation rules for angular momentum - Eigen values and Eigen functions of $L_z$and L^2 - Angular momentum in general - Allowed values of angular momentum J - Eigen valuesof $J_+$and J_-angular momentum matrices - Addition of angular momenta and Clebsh- Gordenco-efficients:Clebsh–Gordenco-efficientforJ_1=J_2=1/2andJ_1=1,J_2=1/2-spinangularmomentumand Pauli's spinmatrices.

UNIT-III:RelativisticQuantumTheory

(MandatoryCore)

PHY401:AdvancedQuantumMechanics

Klein – Gorden Equation – KG equation in Co-variant form- Probability Density and ProbabilityCurrent Density – Inadequacies of K.G. Equation – Dirac’s Relativistic Equation for a FreeParticle -Dirac`s Matrices – Dirac`s Equation in Co-variant form –Plane wave solution –NegativeEnergyStates–Spin AngularMomentum-Existence.

UNIT-IV:Quantization of WaveFields

ConceptofField-MethodofCanonicalQuantization:LagrangianFormulationofField,HamiltonFormulationofField-SecondQuantization–Fieldequation – QuantizationofNon-relativistic Schrodinger equation – Commutation and Anti-Commutation Relations, TheN-representation-System ofFermions andBosons– Creation andAnnihilation.

BooksforStudy

1. QuantumMechanics: ConceptsandApplicationsbyNouredineZettili,Wiley,Ed.,2021
2. IntroductiontoQuantumMechanicsbyDavidJ.GriffithsandDarrellF.Schoeter,ThirdEd.,CambridgeUniversityPress India PvtLtd.,2018.
3. QuantumMechanics: G.AruldasPHIlearningprivatelimitedSecondedition,2018
4. QuantumMechanics:S.L.KakaniandH.M.ChandaliaSultanChandand,SonsFirstEdition,2004
5. AdvancedQuantumMechanics: B.S.Rajput,Pragatiprakasan,2019
6. QuantumMechanics:V.K.Thankappan,NewAgeInternational(P)Ltd.,Publishers,1993
7. ATextbookofQuantumMechanics:P.M.MathewsandK.Venkatesan,TataMcGrawHillPublishingCompany, 2008
8. QuantumMechanics:S.L.Gupta,V.Kumar,H.V.SharmaandR.C.Sharma,JaiPrakashNathandCompany, 2007
9. An IntroductiontoQuantumMechanics,P.T.MathewsMcGraw Hill PublishingCompany,1974

(MandatoryCore)

PHY - 402	Physics of Advanced materials PHY402:Physicsof AdvancedMaterials	L-3,T-1,P-2	4Credits
Pre-requisite: Understanding ofgraduatelevelsolid state physics			
Course Objectives: The aim and objective of the course on Physics of Advanced materials is toexpose the students of M.Sc.class to the topics like crystal growth, dielectricproperties, ferromagnetic properties and functional materials, concepts and applications, so that they are equipped with the investigatingthe matter in the condensed phase.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	Gainin-depthknowledge about theformation of various crystal Growthtechniques		
CO2	Understand the properties dielectric and ferroelectric materials		
CO3	Understand different on Ferro and Anti ferro and ferro magnetism and their applications		
CO4	Study functional materials		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	2	1	-	2	2	1	-
CO2	3	2	2	2	2	2	2	-	2	2	2	-
CO3	3	2	-	2	1	2	2	-	1	2	1	-
CO4	3	2	-	2	2	2	1	-	1	2	2	-

PHY – 402: Physics of Advanced materials

UNIT-I: CrystalGrowthandImperfectionsinCrystals

Crystalgrowth: Nucleation and growth – Homogeneous and heterogeneous nucleation – Classificationofcrystalgrowthtechniques–Meltgrowth:Bridgman,Czochralskitechniques.
Imperfections: Classificationofimperfections–Pointdefects–SchottkyandFrenkeldefects-Expressions for equilibrium defect concentrations – Colourcentres –Production of colourcentres – Linedefects – Dislocations – Edge and Screw dislocations – Burger vector –Estimation of dislocationdensities – Ordered phases of matter-Translationaland orientationalorder

UNIT-II:DielectricsandFerroelectrics

Dielectrics: Introduction–Dipolemoment–varioustypesofpolarization–Electronic,ionicandorientationalpolarization–Langevin’stheory–Lorentzfield–Clausius-Mosottiequation–Measurement of dielectricconstant– Applicationsofdielectrics.

Ferroelectrics: Piezo-, Pyro- and ferroelectric crystals– Spontaneous polarization – Classification andproperties of ferroelectrics – Ferroelectric domains – Oxygen ion displacement theory – Applications offerroelectrics.

UNIT-III:FerromagnetismandAnti-ferromagnetism

Ferromagnetism: Introduction – Weiss molecular field theory – Temperature dependence of spontaneousmagnetization–Heisenbergmodel–Exchangeinteraction–Ferromagneticdomains–Magneticbubbles–Blochwall –Thicknessandenergy–Ferromagneticspin waves–Magnons–Dispersionrelations.
Anti-ferromagnetism: Introduction–Twosublatticemodelofanti-ferromagnetism–Ferrimagnetism-Ferrites – Structure– Applications– Multiferroics

UNIT- IV:FunctionalMaterials

Amorphous semiconductors: Band structure – Electronic conduction – Optical absorption – Applications.Liquidcrystals:Classification– Orientationalorderand intermolecularforces–Magnetic effect– Opticalproperties– Applications.
Polymers:Classification–Structuralpropertycorrelation–Molecularweight–Crystallineinpolymers–Applications.

BooksforStudy

1. SolidStatePhysics,C.Kittel,Edition:8th2012,JohnWiley&Sons.
2. SolidStatePhysics,A.J.Dekkar,Edition: 1st,2000.MacmillanIndiaLtd.
3. SolidStatePhysics,M.A.Wahab,Edition:3rd, 2020,NarosaPublishingHouse.
4. Fundamentalsof SolidStatePhysics,Saxena,Gupta,Saxena,Edition: 31st,2019,Pragathi
5. SolidState Physics,R.L. Singhal,2018,KedarNath,RamNath&Co. Publications,Meerut.
6. ScienceofEngineeringMaterialsandcarbonnanotubes,C.M.SrivastsavaandC.Srinivasan,Edition:3rd,2010 New AgeInter. Pub.
7. CrystalGrowth,B.R.Pamplin,1977,PergmonPress.
8. CrystalGrowthfromHighTemperatureSolutions,D.Elwell andH.J.Scheel,1975,AcademicPress.

(GenericElective)

PHY -403 (a)	Photonics PHY403(a):Photonics	L-3,T-1,P-2	4Credits
Pre-requisite: UnderstandingofgraduatelevelopticsandLasers			
Course Objectives: Course Objectives: The aim and objective of the course on **Photonics**is to expose the M.Sc. students to the basics of the challenging researchfieldof optical fibers andtheir usein integrated optics and photonic crystals.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	In depth knowledge on different lasers and their application		
CO2	Importance of Fiber optics and their components in communication and sensors		
CO3	Significance and role of wageguides and optics in integrated optics		
CO4	Advances in photonic crystals, circuits and applications with respect to conventional devices.		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	1	1	-	-	3	-	1
CO2	3	2	1	1	1	1	-	-	-	3	-	1
CO3	3	2	2	1	2	1	-	-	-	3	-	1
CO4	3	2	1	1	1	2	-	-	-	3	-	1

PHY -403 (a): Photonics

UNIT–I: Lasersystems,PropertiesandApplications

Generaldescription,structure,excitationmechanism andworking ofCO_2,Argonion,Free-electron,Dye,Nd:YAG,Opticalparametricoscillator, semiconductorand erbiumdopedfiberlasers. Laserbeamlinewidth,frequencystabilization,divergenceandcoherence.Q-SwitchingandMethodsofQ-switching.Modelockingandmethods of modelocking.Frequencydoublingandphaseconjugation. Laserapplicationsinisotopicseparation,velocitymeasurements,interferometryandspecklemetrology.

UNIT- II:FiberOpticComponentsandSensors

Connector principles, Fiber end preparation, Splices, Connectors, Source coupling, Distribution networks,Directional couplers, Star couplers, Switches, Fiber optical isolator, Wavelength division multiplexing,Time division multiplexing, Fiber Bragg gratings. Advantage of fiber optic sensors, Intensity modulatedsensors,
Mach-Zehnder interferometer sensors, Current sensors, Chemical sensors –Fiber optic rotation sensors.Opticalbiosensors:Fluorescenceandenergytransfersensing,molecularbeaconsandopticalgeometriesofbio-sensing, Bio-imaging, Biosensing.

UNIT- III: IntegratedOptics

Introduction – Planar wave guide – Channel wave guide – Y-junction beam splitters and couplers –

(GenericElective)

PHY403(a):Photonics

FTIRbeamsplitters–Prism andgratingcouplers–Lenswaveguide–Fabricationofintegratedopticaldevices - Integrated photodiodes – Edge and surface emitting laser – Distributed Bragg reflection and Distributedfeedbacklasers -Wave guide arraylaser.

UNIT-IV:Photonic Crystals

Basics concepts, Theoretical modeling of photonic crystals, Features of photonic crystals, Methods offabrication,Photoniccrystalopticalcircuitry,Nonlinearphotoniccrystals,Photoniccrystalfibers,Photoniccrystals and optical communications, Photonic crystal sensors.

Booksfor Study

1. Lasers:PrinciplesandapplicationsbyJ.WilsonandJ.F.B.Hawkes,Prentice,HallofIndia,NewDelhi, 1996.
2. Laserfundamentals,W.T.Silfvast,Foundationbooks,NewDelhi,1999.
3. FiberOpticCommunication,JosephC.Palais,PearsonEducationAsia,India,2001
4. IntroductionToFibreOptics,A.GhatakAndK.Thyagarajan,CambridgeUniversityPress,NewDelhi ,1999
5. OpticalGuidedWaveSignalDevices,R.SymsAndJ.Cozens.McgrawHill,1993.
6. Optical Electronics,AGhatakandK.Thyagarajan, CambridgeUniversityPress,New Delhi,1991
7. FundamentalsofPhotonics,B.E.A. SalehandM.C.Teich,JohnWillyand Sons,1991
8. Nanophotonics,P.N.Prasad,WileyInterscience,2003.

(GenericElective)

PHY- 403 (b)	SolarEnergy–ThermalandPhotovoltaicProperties	L-3,T-1,P-2	4Credits
Pre-requisite: Understandingof graduatelevel semiconductor physics			
CourseObjectives: The aimandobjectiveofthecourseonSolarEnergy–ThermalandPhotovoltaic Properties is to expose the M.Sc.students to the basics of solarenergy.			
CourseOutcomes: Atthe end ofthecourse, thestudent willbeable to			
CO1	Understandthethermal and light components of solar energy, basicconcepts and measurement of solar radiation.		
CO2	Learn the theoretical aspectsof solar collectors, performance evaluation and application.		
CO3	Know the concepts of solar cells, types and fabrication procedures of source solar cells.		
CO4	Provide knowledge on cell efficiency measurements.		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	1	-	1	2	-	2	3	-	-
CO2	2	2	1	2	1	1	1	-	1	-	-	-
CO3	3	2	-	2	1	1	2	-	1	3	-	-
CO4	2	2	-	2	1	1	2	-	1	-	-	-

PHY403(b):SolarEnergy–ThermalandPhotovoltaicProperties

UNIT-I: BasicConcepts of SolarEnergy

Introduction - Distribution of solar radiation – Solar Constant, Zenith Angle, Air Mass, Standard Time,Local Apparent Time, Equation of Time, Declination, Hour Angle, Azimuth Angles (all definitions only).RadiationMeasurement usingPyranometer andPyrheliometer–Principleand working. Kirchoff's law – Solar transmittance, absorptance, emittance and reflectance – Their relation.Selectivecoatings - Methods of Preparation of coatings - Measurement of solar absorptance and emittance of aselectivesurface.

UNIT- II:SolarThermalCollectors

Introduction, Collector types - Flat plate collector (FPC), Evacuated tube collector – Energy balanceequation and efficiency, Definitions of collector overall heat loss coefficient, collector efficiency factor,collector heat-removal factor and collector flow factor, Temperature distribution in FPC - Testing of FPC,solar water heating - natural and forced circulation type; Concentrating collectors, types, single axis andtwo-axis tracking – Performance of Linear parabolic trough concentrator, Applications - Space heating,Air heater - Configurations - Drier - Principle and working; Energy storage - Sensible heat storage- liquidandpebble-bed storage,Thermochemicalstorage.

UNIT–III: SolarCells

Photovoltaic effect – Equivalent circuit of solar cell - Definitions of cell parameters, Type of cells,Crystalline silicon (c-Si), Float zone and Czochrolski methods - Wafer to cell formation steps**,** Poly-Siwafer growth methods – EFG, Web, Heat exchange method, Amorphous Si cells. Thin film cells –Advantagesandlimitations – CdTe/CdS,CuInGaSe2/CdSandGaAscells –

Configurationsandstructures
– Fabrication of these cells - I-V characteristics and spectral response - Multijunction cells - Quantum dot,Dyesensitized and Perovskitecells.

UNIT–IV:SolarPhotovoltaicSystems

Photovoltaic (PV) Module assembly - Description of steps involved in the fabrication of solar module -Performance of module – I-V Characteristics, Modules design for different current and voltages – Moduleprotection - Use of bypass and blocking diodes, Solar PV system - Components – PV Array, battery,invertor and load. Bifacial solar modules – Advantages over mono-facial cells; Applications of solar PVsystems–Stand-alonesystem–Designmethodologies,Hybridsystem–Typesandissues,Gridconnectedsystems.

BooksforStudy

1. SolarEnergyUtilization,G.D.Rai,KhannaPublishers,1987.
2. SolarEnergy-Fundamentals,Design,ModellingandApplications,G.N.Tiwari,NarosaPublications,2005.
3. Solar Energy-PrinciplesofThermalEnergyCollection&Storage,S.P.Sukhatme,TataMc-GrawHillPublishers, 1999.
4. ScienceandTechnologyofPhotovoltaics,P.JayaramaReddy,CRCPress(Taylor&FrancisGroup,Leiden,Netherlands)&BSPublications,2009.
5. SolarPhotovoltaics-Fundamentals,TechnologiesandApplications,ChetanSinghSolanki,PHILearningPvt. Ltd.,2015.

(GenericElective)

PHY-403 (c)	VacuumandThin FilmTechnology	L-3,T-1,P-2	4Credits
Pre-requisite:courseinCondensedMatterPhysics			
Course Objectives: The main objective of the course on vacuum and thin film technology isto introduce the basic and advanced concepts in the field of vacuum and thin films. The students are not only exposed to theoretical concepts but also have hands-on training in the preparation of thin films. The students also are exposed to various industrial applications of vacuum and thin films			
CourseOutcomes: At theend ofthe course, thestudent will be ableto			

CO1	Basic theoretical concepts of the kinetic theory of gases applicable to vacuumtechnology and also the principles and construction of various vacuum pumps and gages.
CO2	Design and construction of various techniques for the preparation of thin films
CO3	Theoretical aspects to understand the growth and properties of thin films
CO4	Various industrial applications of thin films

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	**3**	2	3	1	2	-	3	2	3	-
CO3	3	3	3	-	3	1	-	-	3	-	3	-
CO3	3	2	-	2	2	1	1	-	1	2	1	-
CO4	3	3	-	3	-	1	1	-	3	-	3	-

PHY403(c): VacuumandThin FilmTechnology

UNIT-I:Basics of Vacuum

Fundamentalsofkinetictheoryapplicabletovacuumtechnology-Vacuumpumps:Rotarypump - Roots pump – Sorption pump – Diffusion pump -Turbo molecular pump – Cryogenic pump -Vacuum Gauges: Pirani gauge - Penning gauge - Hot cathode ionization gauge – Bayard – Alpertgauge –Quadruple mass spectrometer - Pump combinations – Design of vacuum systems – LeaksandLeak detection-Applications of vacuum.

UNIT-II:PreparationofThinFilms

PhysicalMethods:Vacuumevaporation-Resistiveheating-Electronbeamevaporation-Co-evaporation-Epitaxialdeposition:Pulsedlaserablation-Molecularbeamepitaxy.Sputtering-Glow discharge-DC andRFsputtering-Reactivesputtering-Magnetronsputtering - Chemical methods: Electroplating – Spray pyrolysis – Chemical vapor deposition (CVD) - Sol-gel– Spin coating.

Measurement of film thickness -Multiple beam interferometer (MBI) methods – Quartz crystalthicknessmonitor -Stylus profiler.

UNIT-III: Properties ofThinFilms

(GenericElective)

TransportPropertiesofThinFilms**:**MetallicFilms:Sourcesofresistivityinmetallicconductors – sheet resistance and temperature coefficient of resistance of thin films – Influence of thicknesson the resistivity of structurally perfect thin films – Fuchs Sondhemier theory – Annealing andagglomeration - Optical Properties -Reflection and transmission by single film and multilayerfilms -Optical absorption– Determinationofoptical constants byEllipsometry.

UNIT-IV:ApplicationsofThin Films

Photolithography-PatternGeneration-Thinfilmresistors–Thinfilmcapacitors–Thinfilmdiodes and transistors – Thin film solar cells - Thin film microbatteries – Thin film Gas sensors – Reflection and antireflection coatings - Optical filters - Transparent conducting oxide coatings -Hardcoatings-Tribologicalcoatings.

BooksforStudy

1. VacuumTechnology,A.Roth,North-Holland,1986.
2. VacuumScienceandTechnology,V.VasudevaRao,T.B.Ghoshand K.L.Chopra,AlliedPublications,1998.
3. HandbookofThinFilmTechnology, L.I.MaisselandR.L.Glang,McGrawHillBookCo.,1970.
4. ThinFilmPhenomena,K.L.Chopra,McGrawHillBookCo.,NewYork,1969.
5. VacuumDepositionontoWebs,FilmsandFoils,CharlesA.Bishop,Elsevier,London,2011.
6. TheMaterialsScienceof ThinFilms,M.Ohring,AcademicPress,New York,1992.
7. TheUser’s Guide toVacuum Technology,J.F.O’Henlon, John Wiley&Sons, 2003.

(MultidisciplinaryCourse)

PHY-405	Advanced characterization techniques	L-3,T-1,P-0	4Credits
Pre-requisite: Understandingof graduatelevelchemistryandphysics			
Course Objectives: The aim and objective of the course on AdvancedcharacterizationTechniques is to familiarize the M.Sc. students with the basics of the recently emergingresearchfield ofdynamics ofStructures,Spectraand propertiesofvarious instruments			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	Describevarious Instrumentation – Essential partsofspectrophotometer.		
CO2	UnderstandtheoreticaltechniquesResonanceSpectrometersandMassSpectrometer		
CO3	Understanduseofvariousspectroscopictechniquesandtheirapplicationtothevarious fields of physics.		
CO4	UnderstandtheAdvancedSpectroscopicandMicroscopicTechniques		

Mappingof courseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	2	1	2	-	2	-	-	-
CO2	3	2	1	2	2	2	2	-	2	-	1	2
CO3	3	2	1	2	1	2	2	-	2	-	-	2
CO4	3	3	1	2	2	2	2	-	2	-	1	-

PHY405:AdvancedCharacterizationTechniques

UNIT–I:Spectrophotometry

Introduction – Beer's law – Absorptivity – UV and visible absorption –Instrumentation – Essential partsofspectrophotometer–IRSpectrophotometry–FourierTransformInfrared(FTIR)Spectrometer–Molecular structure – Qualitative and Quantitative analysis–Raman Spectroscopy – Qualitative andQuantitative analysis. Fourier Transform (FT) Raman Spectroscopy and its additional advantages overtheconventionalRaman Spectroscopy,

UNIT–II: ResonanceSpectrometersandMassSpectrometer

ElectronSpinResonance(ESR)–Principle–ESRspectrometer–WorkingPrinciplewithblockdiagram – Applications of ESR. Nuclear Magnetic Resonance (NMR) – Principle – NMR spectrometer – WorkingPrinciple with block diagram – Experimental techniques –. Basic concepts of NQR spectra: Half integralandintegralspins,Instrumentation,Superregenerativeoscillator,applicationsofNQR.Mossbauere ffect – theory – Mossbauer spectrometer – Principle and working of Mossbauer spectrometer –

Experimentalmethodswithblockdiagram– Applications ofMossbauerstudies.

UNIT–III:AdvancedSpectroscopicandMicroscopicTechniques

Spectroscopic Techniques: Energy Dispersive Spectroscopy, X-ray Photo Electron Spectroscopy, X rayFluorescenceSpectroscopyandAugerElectronSpectroscopy, SecondaryIonMassSpectrometry. ImagingTechniques:ScanningElectronMicroscopy,TransmissionElectronMicroscopy,AtomicForceMicroscopy,
DiffractionTechniques:X-Raydiffraction –Lauemethod–Powdermethod.

BooksforStudy

1. ElementsofX-rayDiffraction,B.D.Cullity,3rd Ed.,PearsonEducationLtd.,2014.
2. MethodsofSurfaceAnalysis,TechniquesandApplications,J.M.WallsCambridge
3. UniversityPress, 1990.
4. X-rayStructureDetermination,H.StoutandLH.Jenson,Macmillan,London,1968.
5. InstrumentalMethodsofAnalysis,WillardMerritt,DeanSettle,CBSpublishers,
6. New Delhi,1986
7. Spectroscopy,B.P. Straughan and S.Walker,John Wiley&Sons Inc.,NewYork,1976.
8. Spectroscopy,G.Chatwal and S.Anand,Himalaya Pub.,2002.
9. Spectroscopy,B.K.Sharma,GoelPublishersHouse,Meerut,1975.
10. BasicprinciplesofSpectroscopybyRaymondChang,MicGrawHill,1971
11. MolecularStructureandSpectroscopybyG.Aruldas,PrenticeHall ofIndia,2001

(OpenElective)

PHY-406 (a)	Wireless Communications	**L-3,T-1,P-2**	**4Credits**
Pre-requisite: Understandingof graduatelevelchemistryandphysics			
Course Objectives: The aim and objective of the course on Wireless Communicationsis to familiarize the M.Sc. students with the basics of the recently emergingmobile technologies.			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	understand the basics of digital modulation techniques		
CO2	Understand various coding and error correction techniques		
CO3	Know GSM mobile communication standards, its architecture, logical channels, advantages and limitations.		
CO4	Familiarize with optical and satellite communication techniques		

Mappingof courseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	2	-	2	-	2	2	-	1
CO2	3	2	1	2	2	2	-	-	2	2	-	-
CO3	3	2	1	2	1	2	2	-	2	2	-	1
CO4	3	2	1	2	2	-	-	-	2	2	-1	-

PHY 406 (a): Wireless

CommunicationsUNIT– I: BaseBand DataTransmission

Digital Modulation techniques: BPSK, QPSK, DPSK, QASK, BFSK, MSK, M-ary techniques.Base band binary data transmission system – Inter symbol interference – Nyquist pulse shapingcriteria–linecoding,pulseshaping,andscramblingtechniques,Detectionoferrorprobability.

UNIT–II:CodesforErrorDetection and Correction

Linearblockcodes,Convolutionalcodes.Encoding,Decodingofconvolutionalcodes,State,Tree and Trellis diagrams. Maximum likelihood – Viterbyalgorithm, Burst error correction - Interleavingtechniques–Block andconvolutionalinterleaving, TypesofARQ.

UNIT–III:Introduction toWirelessCommunicationSystems

Globalsystemformobile(GSM):cellularconcept,systemdesign.Transmissionsystem,receiving system; frequency re-use; Spread spectrum modulation; Multiple access techniques asappliedto wireless communications; 1G,2G, 3G wireless networks.

(OpenElective)

UNIT–IV:Satelliteand OpticalCommunications

IntroductionSatellitesystems:Orbitingsatellites,satellitefrequencybands,communicationsatellitesystem-modulationandmultipleaccessformat-satellitesystemsinIndia,Satellitereceivingsystems,G/Tratio,satelliteuplinkanddownlinkanalysis.Applicationstocommunications and remote sensing. Introduction to Optical communications systems: Opticalfibers,sources and detectors, analogand digital systems.

BooksforStudy

1. ModernDigitalandAnalogcommunicationsystembyB.P.Lathi:.Oxford 3rd ed.,2011
2. DigitalCommunicationsFundamentalsandApplicationsbyBernardSklar,SklarPersonEducation,2008
3. PrinciplesofCommunicationSystems:Taub&Schilling,TataMcGraw-Hill,1991
4. PrinciplesofCommunication,R.E.Ziemer,WHTranterFifthEditionJohnWiley(fifthmodule)
5. WayneTomoasi:MordenElectronicCommunicationSystems.PersonEducation/PHI,2014
6. JohnGProakis:DigitalCommunication.MGH
7. DigitalCommunicationTechniquesSimon, HindeyLindseyPHI
8. CommunicationSystems:SimonHaykin,JohnWiley&Sons.Pvt.Ltd.
9. DigitalandAnalogCommunicationSystem:KSamShanmugam.JohnWiley
10. CommunicationSystemsEngineering:Proakis,PearsonEducation
11. Digital &AnalogCommunicationSystem– Leon WCouch,PearsonEducation/PHI.
12. IntroductiontostatisticalSignalProcessingwithApplicationsMDSrinath,P.K.Rajasekaran,RE. Viswnathan PHI
13. AnalogandDigitalCommunicationMSRodenPHI
14. Digitalmodulationandcoding.Wilson,PearsonEducation
15. AppliedcodingandinformationTheoryforengineers,Wells,Pearson education.

(OpenElective)

PHY-406 (b)	VacuumTechnology and applications	**L-3,T-1,P-2**	**4Credits**
Pre-requisite:courseinCondensedMatterPhysics			
Course Objectives: The main objective of the course on vacuum technology and applications is to introduce the basic and advanced concepts in the field of vacuum technology. The students are not only exposed to theoretical concepts but also have hands-on training in the construction of various vacuum pumps, vacuum measuring gauges, and thin film preparation techniques. The students also are exposed to various industrial applications of vacuum and thin films			
CourseOutcomes: At theend ofthe course, thestudent willbe ableto			
CO1	Basic theoretical concepts of the kinetic theory of gases applicable to vacuum technology and also the principles and construction of various vacuum pumps and gages for the production and measurement of vacuum		
CO2	Design and construction of various components for the construction of vacuum systems for the preparation of thin films		
CO3	Various techniques used for the growth of thin films		
CO4	Various industrial applications of vacuum technology and thin films		

Mappingofcourseoutcomeswiththeprogramoutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	-	2	-	3	1	-	-
CO3	2	3	3	3	3	1	-	-	3	2	-	-
CO3	2	2	2	2	2	-	1	-	1	1	-	-
CO4	3	3	3	3	3	-	-	-	3	3	-	-

406 (b) Vacuum Technology and

ApplicationsUNIT-I:**BasicsofVacuum**

Vacuum – definition – Units of Vacuum – Vacuum ranges - Kinetic theory of gases related tovacuum -Physicalparameters at lowpressures–Vacuumcomponents- Applications ofvacuum – Vacuum metallurgy – Freeze drying – Vacuum in electrical applications – Spacesimulators– Leaks anddetection of leaks– Pressure test– Halogen leak detector– Massspectrometricleak detection.

UNIT-II:**ProductionandMeasurementof Vacuum**

Classification of vacuum pumps – Rotary pump – Roots pump – Sorption pump – Diffusionpump– Turbo-molecular pump–Ion pump – Cryogenicpump.
Classification of vacuum gauges – McLeod gauge – Pirani gauge – Ionization gauges – Penninggauge – Bayard Alpert gauge – Measurement of partial pressure –Residual gas analyzer – Pumpcombinations– Construction ofhigh vacuumcoatingsystem.

UNIT-III:**PreparationofThinFilms**

(OpenElective)

Physical Methods- Vacuum evaporation - Resistive heating - Electron beam evaporation - Co-evaporation.
Epitaxialdeposition-Pulsedlaserablation-Molecularbeamepitaxy.
Sputtering - Glow discharge - DC and RF sputtering - Reactive sputtering - Magnetron sputteringChemical methods: Electroplating – Spray pyrolysis – Chemical vapour deposition (CVD) -Sol-gel– Spin coating.

UNIT-IV:**ApplicationsofThinFilms**

Photolithography-Pattern generation- Thin film resistors – Thin film capacitors – Thin filmdiodes and transistors – Thin film solar cells - Thin film microbatteries – Thin film gas sensors –Reflection and antireflection coatings - Optical filters - Transparent conducting oxide coatings -Hardcoatings-Tribological coatings.

BooksforStudy

1. VacuumTechnology,A.Roth,3rd Edition,North-HollandPublications,2012.
2. VacuumScienceandTechnology,V.V.Rao,T.B.GhoshandK.L.Chopra,3rdEditions,Allied Publications, 2008.
3. HandbookofThinFilmTechnology,L.I.MaisselandR.L.Glang,McGrawHillBookCo.,1970.
4. ThinFilm Phenomena,K.L.Chopra, McGraw Hill Book Co., New York,1969.
5. VacuumDepositionontoWebs,FilmsandFoils,CharlesA.Bishop,Elsevier,London,2015
6. TheMaterialsScienceof ThinFilms,M.Ohring,AcademicPress,New York,1992.
7. TheUser’s Guideto Vacuum Technology,J.F.O’Henlon, John Wiley&Sons, 2003.