M.Sc. Year V (Semester-IX)										
			Teaching Scheme (Hours)			Examination Scheme				
Sr. No.	Course Code	Course Name	L	T	P	Credits	Theory	Tutorial	Practical	Total Marks
1	PH 501	Dissertation – I/Dissertation Part A	0	0	30	15	0	0	500	500
		Total	**0**	**0**	**30**	**15**	**0**	**0**	**500**	**500**
		Total Contact Hours	**30**							
		Total Credits	**15**							

OR

M.Sc. Year V (Semester-IX)										
			Teaching Scheme (Hours)			Examination Scheme				
Sr. No.	Course Code	Course Name	L	T	P	Credits	Theory	Tutorial	Practical	Total Marks
1	PH 503	Elementary Excitations in Solids	3	1	0	4	100	25	0	125
2	PH 5AA	Core Elective – V	3	0	0	3	100	0	0	100
3	PH 5BB	Core Elective – VI	3	0	0	3	100	0	0	100
4	PH 505	Dissertation Preliminaries	0	0	10	5	0	0	125	125
		Total	**9**	**1**	**10**	**15**	**300**	**25**	**125**	**450**
		Total Contact Hours	**20**							
		Total Credits	**15**							

PH 521: Microcontrollers
PH 541: Non Destructive Testing

PH 523: Research Methodology and Data Analysis in Physics
PH 543: Electromagnetic Communication

M.Sc. Year V (Semester-X)

			Teaching Scheme (Hours)			Examination Scheme				
Sr. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**	**Theory**	**Tutorial**	**Practical**	**Total Marks**
1	PH 502	Dissertation – II/Dissertation Part B	0	0	30	15	0	0	500	500
		Total	**0**	**0**	**30**	**15**	**0**	**0**	**500**	**500**
		Total Contact Hours	**30**							
		Total Credits	**15**							

Fifth year of Five Years Integrated M.Sc.(Physics) M.Sc. – V, Semester – IX	L	T	P	C
PH 503: Elementary Excitations in Solids	**3**	**1**	**0**	**4**

Course Outcomes **In the end of the semester students will able to:**	
CO1	understand the concepts and the principles of elementary excitations in solids
CO2	identify the relevance of approximation methods in elementary excitations in solids and extend the concept to explain the dynamics of complex systems
CO3	understand the relevance of elementary excitation in real in real life
CO4	understand the relevance of elementary excitations in solids
CO5	understand the meaning of second quantization

Syllabus	
INTRODUCTORY SURVEY	**(08 Hours)**
General considerations, Basic Hamiltonian, Elementary excitations, The measurement of the elementary excitation spectrum.	
PHONONS	**(08 Hours)**
Lattice dynamics in one dimension, lattice dynamics in three dimension, lattice specific heat, melting criterion, neutron scattering in solids, Phonon-phonon interactions.	
ELECTRONS AND PLASMONS	**(06 Hours)**
Sommerfeld non-interacting electron gas, Hartree and Hartree-Fock approximations, correlation and correlation energy, dielectric response of an electron system, Properties of the electron gas in the RPA, Properties of the electron gas at metallic densities.	
ELECTRONS, PLASMONS, AND PHOTONS IN SOLIDS	**(05 Hours)**
Introductory considerations, Experimental observation of Plasmons in solids, optical properties of solids, optical studies of solids.	
ELECTRON-PHONON INTERACTION IN METALS	**(10 Hours)**
Basic Hamiltonian, New features associated with the electron-phonon interaction, General physical picture, High temperature conductivity, Low temperature conductivity, Quasi-particle properties.	
SECOND QUANTIZATION	**(10 Hours)**
Quantization of free fields, elastic and electromagnetic fields, quantization of free fields, boson and fermion fields, illustration from problems in scattering	
(Total Contact Time: 42 Hours)	

BOOKS RECOMMENDED:

1. L. I. Schiff, Quantum Mechanics, McGraw-Hill, New York, 1968.
2. Nakajima S., Toyozawa Y, Abe R., The Physics of Elementary Excitations, Springer-Verlag, 1980.
3. David Pines, Elementary Excitations in Solids, Westview Press, 1999.
4. J. T. Devreese, Elementary Excitations in Solids, Molecules, and Atoms, Pienum Press, London, 1974.
5. Steven M. G. and Kun Yang. Modern Condensed Matter Physics, Westview Press, 1999.

Fifth year of Five Years Integrated M.Sc.(Physics) M.Sc. – V, Semester – IX	L	T	P	C
PH 521: Microcontrollers	**3**	**0**	**0**	**3**

Course Outcomes **In the end of the semester students will able to:**	
CO1	compare the microprocessors and microcontrollers
CO2	understand the architecture of 8051 microcontroller
CO3	outline the fundamentals of timers and counters
CO4	analyze the assembly language programming of 8051 microcontroller
CO5	identify the interfacing and data transmission characteristics of 8051 microcontrollers

Syllabus	
MICROCONTROLLERS	**(06 Hours)**
Introduction to Microcontrollers, Microprocessors and Microcontrollers, Microcontroller survey, 4, 8, 16, and 32 bit Microcontrollers.	
MICROCONTROLLER-8051 ARCHITECTURE	**(08 Hours)**
8051 architecture, Functional blocks, Internal memory, Input- output pins, I/O Ports, External memory, Addressing modes.	
TIMERS AND COUNTERS	**(08 Hours)**
Logical separation of program and data memory, timers/counters and programming of counters and timers, register in serial data input/output, serial data Transmission modes.	
PROGRAMMING 8051	**(10 Hours)**
Assembly language Programming, Programming tool and techniques. Assembly Language programming for 8051 microcontroller, Data transfer Instruction, Arithmetic instruction, Branch Instructions, Bit manipulation instruction, rotate Instruction, Instructions stack operation, calls and subroutines, Interrupts and returns.	
INTERFACING 8051 AND DATA TRANSMISSION	**(10 Hours)**
External Memory and Memory space decoding, Memory Mapped i/o, Memory decoding, Timing subroutines, Time delay using software and timer, Look up tables, Serial data transmission, Character Transmission by polling, Interrupt Driven Character Transmission and reception.	
(Total Contact Time: 42 Hours)	

BOOKS RECOMMENDED:

1. Ayala K. J., 8051 Microcontroller : Architecture, programming and applications, Penram International 1997
2. Mazidi M. A. and Mazidi J. G.8051 microcontroller and embadded systems, Pearson Education 2003
3. Calcutt D. M., Cowan F. J., Parchizadeh G. H., 8051 microcontrollers: hardware, software, and applications Elsevier 1998
4. Predko M. Programming and customizing the 8051 microcontroller Tata McGraw-Hill 2007
5. MacKenzie I. S. The 8051 microcontroller Prentice Hall 1995

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PH 523: Research Methodology and Data Analysis in Physics	**3**	**0**	**0**	**3**

Course Outcomes **In the end of the semester students will able to:**	
CO1	analyze uncertainties in measurements, probability distributions and error analysis
CO2	determine the appropriate research theory for problem
CO3	evaluate data collection from proper method
CO4	examine data by statistical approach
CO5	justify the hypothesis and conclude the limitation of it
CO6	design the report base on interpretation of the data

Syllabus	
UNCERTAINTIES IN MEASUREMENTS, PROBABILITY DISTRIBUTIONS, ERROR ANALYSIS	**(08 Hours)**
Uncertainties in Measurements: Measuring Errors, accuracy and Precision, systematic errors, Random errors, Significant figures and Round off, Uncertainties, Parent and Sample Distributions, Mean, median and mode, Standard Deviation of Distributions. Probability Distributions: Binomial Distributions, Poisson distribution, Gaussian or Normal Error Distribution, Lorentzian Distribution. Selected problems and examples. Error Analysis: Instrumental and Statistical Uncertainties, Propagation of Errors, Specific Error Formulas withy examples, Application of Error Equations. Numerical Errors, Conditioning and Stability, Convergence of Iterative Processes	
RESEARCH THEORY	**(08 Hours)**
Research theory and practice: Research basics, Research theory, Structuring the research project, Research ethics, Finding and reviewing the literature. Defining the Research Problem: Selection of a research Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem: An Illustration. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs	
DATA COLLECTIONS	**(08 Hours)**
Measurement in Research: Measurement Scales, Sources of Error in Measurement, Tests of Sound Measurement, Technique of Developing Measurement Tools. Scaling: Meaning of Scaling, Scale Classification Bases, Important Scaling Techniques, Scale Construction Techniques. Methods of Data Collection: Collection of Primary Data, Observation Method, Collection of Data through Schedules, Some Other Methods of Data Collection	
DATA ANALYSIS	**(08 Hours)**
Processing and Analysis of Data: Processing Operations, Some Problems in Processing.	

Elements/Types of Analysis: Statistics in Research, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness), Measures of Relationship, Simple Regression Analysis, Multiple Correlation and Regression, Partial Correlation, Association in Case of Attributes.	
HYPOTHESES	**(08 Hours)**
Testing of Hypotheses-I (Parametric or Standard Tests of Hypotheses): Basic Concepts Concerning Hypothesis and Testing of Hypotheses, Procedure for Hypothesis Testing, Flow Diagram for Hypothesis Testing, Measuring the Power of a Hypothesis Test, Tests of Hypotheses. Important Parametric Tests, Hypothesis Testing of Means, Hypothesis Testing for Differences between Means, Hypothesis Testing for Comparing Two Related Samples. Hypothesis Testing of Correlation Coefficients, Limitations of the Tests of Hypotheses.	
WRITING	**(04 Hours)**
Interpretation and Report Writing: Technique of Interpretation, Precaution in Interpretation. Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report Types of Reports ,Mechanics of Writing a Research Report, Precautions for Writing Research Reports	
(Total Contact Time: 42 Hours)	

BOOKS RECOMMENDED:

1. Research Methods the Basics by Nicholas Walliaman, Taylor and Francis London& New York 2011.
2. Research Methodology- Methods and Techniques 2nd edition. By C R Kothari, New Age Int. Publ. 2004.
3. Data Reduction and Error Analysis for the Physical Sciences 3rd Ed by Philip R Bevington & D Keith Robinson, McGraw – Hill (2003)
4. Numerical Methods by Balagurusamy, Tata McGraw – Hill (2000)
5. Numerical Analysis, 2nd Ed. by Francis Scheid, McGraw-Hill (2009)

Additional books:

6. Numerical mathematical Analysis, James B Scarboroughs
7. Numerical Methods for Scientists and Engineers, K Sankara Rao, 3rd Ed. PHI

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PH 541: Non Destructive Testing	**3**	**0**	**0**	**3**

Course Outcomes **In the end of the semester students will able to:**	
CO1	understanding of stress strain relationships and the application of these to mechanical behaviour of a broad range of materials
CO2	evaluate mechanical behaviour, measurements of mechanical properties and test methods.
CO3	calculates and interprets mechanical properties using Griffith equation
CO4	importance of non-destructive testing in quality assurance
CO5	analyze basic of non-destructive testing to detect internal material defects
CO6	understanding the dye penetrant test and magnetic particle test to detect surface defects

Syllabus	
INTRODUCTION TO NON DESTRUCTIVE TESTING	**(02 Hours)**
MECHANICAL BEHAVIOR OF MATERIALS	**(10 Hours)**
Engineering Stress, Engineering Strain, True Stress, True Strain, Shear Stress, Shear Strain, Tensile Test (Tension Test), Elastic and Plastic deformation, Ductility, Toughness, Resilience, Hardness, Hardness testing method, Fatigue, Creep. Dislocations & Plastic deformation and Mechanisms of Plastic deformation in metals (Slip System and Twinning), Critical Resolved Shear Stress (Schmid's law), Strengthening Mechanisms in Metals, Recovery, Recrystallization and Grain growth.	
FRACTURE MECANICS AND MODES OF FAILURES	**(08 Hours)**
Types of fractures – Ductile and brittle fractures, Types of Fracture in materials Intergranular Fracture and Transgranular (Intragranular) Fracture**,** Features of fracture surface for Ductile and Brittle fractography. Stresses around cracks - linear elastic fracture mechanics, Griffith's criterion for brittle crack propagation, Fracture Toughness, Impact testing, Ductile to Brittle Transition Temperature	
VISUAL TESTING	**(04 Hours)**
Fundamentals of Visual Testing, Basic principle, The Eye (defect which can be detected by Unaided visual inspection), Optical aids used for visual inspection, Microscope, Borescope, Endscope, Fibroscope, Holography, Application and Limitation of Visual Testing, Standards and Specifications (ASME, ASTM, AWS, BIS etc.)	
LIQUID PENETRANT TESTING	**(04 Hours)**
Introduction to Penetrant testing, Penetrants and their application, penetrant removal, Drying, developing, inspection, equipment's and control checks, Limitations	
MAGNETIC PARTICLE TESTING	**(08 Hours)**

Theory of magnetism - ferromagnetic, Paramagnetic materials - magnetization by means of direct and alternating current - surface strength characteristics - Depth of penetration factors, Direct pulsating current typical fields, advantages - Circular magnetization techniques, field around a strength conductors, right hand rule field - Prods technique, current calculation - Longitudinal magnetization.

ULTRA SONIC TESTING	**(08 Hours)**

Nature of sound waves, wave propagation - modes of sound wave generation Various methods of ultrasonic wave generation - Principle of pulse echo method, through transmission method, Resonance Method - Advantages, limitations - contact testing, Immersion Testing.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. V. Raghavan, Materials Science and Engineering: A First Course, PHI; 5th edition (30 July 2011).
2. William F. Smith, Javad Hashemi, Ravi Prakash, Material Science and Engineering (In Si Units), McGraw Hill Education; 5th edition (1 July 2017).
3. George E. Dieter, Mechanical Metallurgy, 3th edition, McGraw Hill Education 2017.
4. Krautkramer J. and Krautkramer H., Ultrasonic Testing of Materials, Springer-Verlag 1983.
5. Shull P.J., Nondestructive Evaluation: Theory, Techniques, and Applications, Marcel Dekker Inc 2002.

Additional books:

6. Hellier, C., Handbook of Nondestructive Evaluation, McGraw-Hill Professional, 2001.
7. Bray, D.E. and R.K. Stanley, Nondestructive Evaluation: A Tool for Design Manufacturing and Service, CRC Press, 1996.
8. Non-destructive Evaluation and Quality Control, Volume 17, 9th edition, ASM Handbook (1992).

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PH 543: Electromagnetic Communication	**3**	**0**	**0**	**3**

Course Outcomes **In the end of the semester students will able to:**	
CO1	understand the characteristics of transmission lines and cables
CO2	classify the categories of microwave systems and elements of waveguides
CO3	summarize the propagation properties of radio waves
CO4	understand the fundamentals of antenna design and its applications
CO5	examine the key factors associated with the satellite communications

Syllabus	
TRANSMISSION LINES AND CABLES	**(10 Hours)**
Primary Line Constants, Phase Velocity and Line Wavelength, Characteristic Impedance, Propagation Coefficient, Phase and Group Velocities, Standing Waves, Lossless Lines at Radio Frequencies, Voltage Standing-wave Ratio, Slotted-line Measurements at Radio Frequencies, Transmission Lines as Circuit Elements, Smith Chart, Time-domain Reflectometry, Telephone Lines and Cables, Radio-frequency Lines, Microstrip Transmission Lines, Use of Mathcad in Transmission Line Calculations	
INTRODUCTION TO MICROWAVE THEORY AND WAVEGUIDES	**(08 Hours)**
Electromagnetic wave equation, Microwave, microwave frequency bands, Categories of microwave systems, Applications, Introduction to Waveguides, Rectangular Waveguides, Other Modes	
RADIO-WAVE PROPAGATION	**(08 Hours)**
Propagation in Free Space, Tropospheric Propagation, Ionosphere Propagation, Surface Wave, Low Frequency Propagation and Very Low Frequency Propagation, Extremely Low-frequency Propagation, Summary of Radio-wave Propagation	
ANTENNAS	**(06 Hours)**
Antenna Equivalent Circuits, Coordinate System, Radiation Fields, Polarization, Isotropic Radiator, Power Gain of an Antenna, Effective Area of an Antenna, Effective Length of an Antenna, Hertzian Dipole, Half-wave Dipole, Vertical Antennas, Folded Elements, Loop and Ferrite-rod Receiving Antennas, Nonresonant Antennas, Driven Arrays, Parasitic Arrays, VHF-UHF Antennas, Microwave Antennas	
SATELLITE COMMUNICATIONS	**(10 Hours)**
Telephone Systems, Wire Telephony, Public Telephone Network, Problems Facsimile And Television, Facsimile Transmission, Television, Television Signal, Problems, Introduction, Kepler's First Law, Kepler's Second Law, Kepler's Third Law, Orbits, Geostationary Orbit, Power Systems, Attitude Control, Satellite Station Keeping, Antenna Look Angles, Limits of Visibility, Frequency Plans and Polarization, Transponders, Uplink Power Budget Calculations, Downlink	

Power Budget Calculations, Overall Link Budget Calculations, Digital Carrier
(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. Roddy D., Coolen J., Electronic Communications, Prentice-hall of India Pvt Ltd. 2007
2. Blake R., Electronic Communication Systems, Thomson Asia 2008
3. George K., Electronic Communication Systems, McGraw-Hill 1992
4. Simon H., Communication Systems, Wiley Eastern 2007
5. Taub and Schilling, Principles of Communication Systems, McGraw-Hill 1991