Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

SYLLABUS

for

Master of Science (M. Sc.)

II

[Physics]

Choice Based Credit System

(Outcome Based Curriculum)

2022 - 2023

Summary of Distribution of Credits under CBCS Scheme
for
M.Sc. (Physics)

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV	Total
01	Core	**16**	**16**	**08**	**08**	**48**
02	Skill based	**04**	**04**	**04**	**04**	**16**
03	Elective	**-**	**-**	**04**	**04**	**08**
04	Project	**-**	**-**	**04**	**04**	**08**
05	Audit	**02**	**02**	**02**	**02**	**08**
06	Total Credits	**22**	**22**	**22**	**22**	**88**

Subject Type	Core	Skill based	Elective	Project	Audit	Total
Credits	**48**	**16**	**08**	**08**	**08**	**88**

Total Credits = 88

Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon

M. Sc. Physics

Choice Based Credit System (Outcome Based Curriculum) with effect from 2021 -2022

Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Practical)	Total Credits	
I	4	16 + 0	**16**	1	0 + 4	**4**	1	2	2	**22**
II	4	16 + 0	**16**	1	0 + 4	**4**	1	2	2	**22**
III	2	08 + 0	**08**	3	4 + 8	**12**	1	2	2	**22**
IV	2	08 + 0	**08**	3	4 + 8	**12**	1	2	2	**22**
Total Credits	**48**			**32**			**8**			**88**

(T, Theory; P, Practical)

Structure of Curriculum

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
	Prerequisite and Core Courses									
(A)	Theory	16	4	16	4	8	2	8	2	48
	Practical					8	2	8	2	16
(B)	**Skill Based / Subject Elective Courses**									
1	Theory /Practical	4	1	4	1	4	1	4	1	16
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course			2	1					2
3	Technology Related + Value Added Course					2	1			2
4	Professional and Social + Value Added Course							2	1	2
	Total Credit Value	22	6	22	6	22	6	22	6	88

***List of Audit Courses** (Select any ONE course of Choice from Semester II; Semester III and Semester IV)*							
Semester I (Compulsory)		**Semester II** (Choose One)		**Semester III** (Choose One)		**Semester IV**(Choose One)	
		Personality and Cultural Development		**Technology + Value Added Course**		**Professional and Social + Value Added Course**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Sport Activities	AC-301B	Cyber Security	AC-401B	Current Affairs
		AC-201C	Yoga	AC-301C	Seminar + Review Writing	AC-401C	Seminar + Review Writing
		AC-201D	Music	AC-301D	Biostatistics	AC-401D	Intellectual Property Rights (IPR)

Semester-wise Course Structure of M.Sc. Subject name

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
PHY-101	Core	Mathematical Methods for Physics	4	--	4	40	--	60	--	4
PHY -102	Core	Classical Mechanics	4	--	4	40	--	60	--	4
PHY -103	Core	Solid State Physics	4	-	4	40	-	60	-	4
PHY -104 A/B/C	Skill Based (Select any one)	**A)**:Physics of Semiconductor Devices **B)**: Electronic Instrumentation **C)** Bio- Physics	4	-	4	40	-	60	-	4
PHY -105	Core	Basic Physics Laboratory – I	-	4+4	8	-	40	-	60	4
AC-101	Audit Course	Practicing Cleanliness	-	2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 16; P = Practical:4; Skill Based:4; Audit Course:2)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
PHY-201	Core	Statistical Mechanics	4	--	4	40	--	60	--	4
PHY -202	Core	Classical Electrodynamics	4	--	4	40	--	60	--	4
PHY -203	Core	Quantum Mechanics	4	--	4	40	--	60	--	4
PHY-204	Skill Based	Material Science	4	-	4	40	-	60	-	4
PHY-205	Core	Basic Physics Laboratory – II	-	4+4	8	-	40	-	60	4
AC-201 A/B/C/D	Audit Course(Select any one)	AC-201A -Soft Skills/ AC-201B- Sport Activities/ AC-201C- Yoga/ AC-201D Music) from Personality and Cultural Development	--	2	2	--	100	--	--	2
Total Credit for Semester II: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit course:2)										

Semester III

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
PHY-301	Core	Atomic and Molecular Physics	4	--	4	40	--	60	--	4
PHY-302 A/B/C	Elective (Select any one)	A)Materials Synthesis and Preliminary Analysis B) Computational Method sand Programming Using 'C' Language C) Acoustics and Entertainment Physics	4	-	4	40		60	-	4
PHY-303 A/B/C	Skill Based(Select any one)	A) Systematic Materials Analysis B) Microprocessor and its Applications C) Communication Electronics	4		4	40		60		4
PHY-304	Core	Special Laboratory-I	-	4+4	8	-	40	-	60	4
PHY-305	Project Based	Project Work-II (Literature Survey, Definition of Problem, Experimental work, Oral etc.)	--	4+4	8	--	40	--	60	4
AC-301 A/B/C/D	Audit Course(Select any one)	**Choose one out of Four (AC-301A-** Computer Skills **/ AC-301B -** Cyber Security**/ AC-301C-** Seminar + Review Writing **/ AC-301D-** Biostatistics**) from Technology + Value Added Courses**		2	2		100	--	--	2
Total Credit for Semester III: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Semester IV

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
PHY-401	Core	Nuclear Physics	4	--	4	40	--	60	--	4
PHY -402 A/B/C	Skill Based	A) Nanomaterials: Synthesis, Properties and Applications B) LASER and it's Applications C) Astrophysics	4	-	4	40	-	60	-	4
PHY-403 A/B/C	Elective (Select any one)	A) Renewable Energy Sources B) Microwave: Applications C)Environmental Physics	4	--	4	40	--	60	--	4
PHY -404	Core	Special Laboratory-II	--	4+4	8	--	40	--	60	4
PHY -405	Project	Project Work-II (Characterization, Analysis of Result, Conclusions, Project	--	4+4	8	--	40	--	60	4

	Based	Report, Oral etc.)								
AC-401 A/B/C/D	Audit Course(Select any one)	**Choose one out of Four (AC-401A-** Human Rights **/ AC-401B –Current Affairs / AC-401C-** Seminar + Review Writing **/ AC-401D -** Intellectual Property Rights (IPR)) **from Professional and Social + Value Added Courses**		2	2		100	--	--	2
Total Credit for Semester IV: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

M. Sc. Programme

Number of teaching days/ year	180
Number of teaching days/ term	90
Number of contact hours for theory course or practical course/ week	04
Number of teaching hours for theory course/ term	52
Number of contact hours/ term for test, seminar and tutorial	08
Total number of contact hours/ term for course	52+08=60

Program at a Glance

Name of the program (Degree)	: M. Sc. (Physics)
Faculty	: Science and Technology
Duration of the Program	: Two years (four semesters)
Medium of Instruction and Examination	: English
Exam Pattern	: 60: 40 (60 marks University exam. And 40 marks continuous internal Assessment)
Passing standards	: 40% in each exam separately (Separate head of passing)
Evaluation mode	: CBCS
Total Credits of the program	: 88 (64 core credits including 4 credits of project/dissertation, 08 skill enhancement credits, 08 subject elective credits and 08 audit credits)

Program Objectives for M.Sc. Program:

The objectives of this Programme are to develop:

1. The students through high quality of education/study which enables them to succeed in career in which can understanding of physics is relevant.

2. The ability to think logically, to analyze problems and phenomena and to devise explanations or solutions.

3. An appreciation of the role of mathematical modeling of physical phenomena to produce predictions which can be tested against experimental observations.

4. An awareness of the importance of accurate experimentation in the understanding of natural phenomena.

5. The practical and technical skills required for physics experimentation.

6. An awareness of the value and the power of computer based techniques for experimentation, analysis and presentation and a familiarity in their exploitation.

7. An ability to communicate the concepts and discoveries of physics both orally and in writing.

8. An ability to organize time and meet deadlines.

9. An additional skills resulting from the experience of more extensive project work.

10. An ability to integrate 'Information Communication Technology' with basic concepts of physics to promote relevant education and training.

11. The qualities of adoptability, innovation and dynamism.

Important Instructions:

1. **B. Sc. (Physics)** students are eligible to offer this program.

2. Two written tests, one oral test and one seminar (per semester) should be conducted for each course in addition to regular teaching schedule.

3. Faculty members are advised to use 'compact disks' and computers as teaching aids so as to ingrain the basic ideas of Physics.

4. Students are advised to borrow scientific information (published worldwide) from scientific websites on Internet**.**

5. A well-equipped computer laboratory with at least 5 computers is necessary to conduct related experiments and Project

6. Student should start the Project work soon after the commencement of third semester. Literature survey, Definition of the problem, Pre-oral before finalization of the topic, Preliminary experimental work, Oral to assign the internal marks etc should be covered in the third semester**.**

7. Student should carry out the experimental work, keep record of the observations and results and should draw the conclusions of the project. Systematic project report should be prepared. Teacher should arrange oral examination to assign internal marks.

Program Outcomes (PO) for M.Sc. Program:

Upon successful completion of the M.Sc. program, student will be able to:

PO No.	PO	
PO1	M.Sc. Physics students can find jobs in public and private sectors. There are many opportunities available for M. Sc. Physics students in technical as well as scientific fields. They can work as Scientist, Assistant Scientist, Quality Control Manager, Laboratory Technician, School Science Technician or Research Analyst in any government or private organization. Besides these, they can also go for teaching in government or private institutions.	**General**

PO2	There are many opportunities available in IT field for M. Sc. Physics graduates. Many IT companies such as Infosys, Wipro and TCS are recruiting M. Sc. Physics graduates for software jobs. They can also get jobs in Energy Plants. Another job available for these graduates is Technician in Electronic Industry. They can apply for jobs in many companies in automobile industry. Some of those companies are Maruti Udyog, TATA Motors and Tech Mahindra.	Private Sector
PO3	: There are vast opportunities available for M.Sc. graduates in Government sector. They can apply for jobs in Scientific Research and Development Organizations such as The Defense Research and Development Organization (DRDO), CSIR, Physical Research Laboratory (PRL) Ahmedabad, Saha Institute of Nuclear Physics Kolkata and Nuclear Science Centre New Delhi. They can also apply for various jobs in popular government organizations such as: • Bhabha Atomic Research Centre (BARC) • Atomic Energy Regulatory Board (AERB) • Oil and Natural Gas Corporation (ONGC) • Bharat Heavy Electricals Limited (BHEL) • National Thermal Power Corporation (NTPC) • Indian Space Research Organization (ISRO) • National Chemical Laboratory (NCL) • Indian Institute of Tropical Meteorology (IITM) They can also apply for the various competitive exams conducted by Union Public Service Commission such as IFS, IPS and IAS. Several other government exams conducted for recruiting M.Sc. Physics graduates are given below: • Tax Assistant Exam, Statistical Investigator Exam, Combined Graduate Level Exam. After qualifying NET or SET exam they can apply for teaching jobs in government colleges or schools. Another option available for M.Sc. Physics graduate is to apply for jobs in public sector banking. Several banks are conducting exam every year for recruiting graduates to the post of Probationary Officers. They can also find many jobs in Railway sector. They should qualify the exams conducted by Railway Recruitment Board to get a job in Railway sector. These graduates can also apply for Combined Defense Services Exams conducted for recruiting candidates to various posts in Defense Department.	Government Sector
PO4	There are wide opportunities available for M. Sc. Physics graduates in foreign countries. They can work in several health care, manufacturing and electronics companies in foreign countries. Students having high percentage during their post-graduation can apply for jobs in National Aeronautics and Space Administration (NASA), one of most famous space research organization in the world.	Foreign countries
PO5	: Those who have completed M. Sc. degree in Physics can find a long term career in the research field. Even though they are joining the research organization as assistant /research fellow (JRF, SRF), can earn lot of experience and/or Ph.D. Degree. After these achievements, they will have chances to get promoted to higher posts.	Long term Career in Research

Program Specific Outcomes (PSOs) for M.Sc. Physics program:

Students who graduate with a Master of Science in **Physics** will:
The Master of Science in Physics program provides the candidate with knowledge, general competence, and analytical skills on an advanced level, needed in industry, consultancy, education, and research.

PSO No.	PSO	Cognitive level
PSO1	Apply the knowledge and skill in the design and development of Electronics circuits to fulfill the needs of Electronic Industry	
PSO2	Become professionally trained in the area of electronics, optical communication nonlinear circuits, materials characterization and lasers.	
PSO3	Pursue researches related to Physics and Materials characterization	
PSO4	Demonstrate highest standards of Actuarial ethical conduct and Professional Actuarial behavior, critical, interpersonal and communication skills as well as a commitment to life-long learning	
PSO5	Prepare students to become Physics professionals with comprehensive knowledge and Practical skills for emerging requirement	
PSO6	Prepare students who will achieve peer-recognition; as an individual or in a team; through demonstration of good analytical, design and implementation skills.	
PSO7	To prepare them to take up higher studies of interdisciplinary nature.	
PSO8	To give exposure to a vibrant academic ambience and To create a sense of academic and social ethics among the students	

Distribution of Course papers for M.Sc. Part II (Physics)

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part II (Subject Name)					
Semester III : Theory Courses					
PHY -301	**Atomic and Molecular Physics**	**Core course**	**04**	**100**	**03**
PHY-302	**Any ONE of the following** **A) Materials Synthesis and Preliminary Analysis OR** **B)Computational Methods and Programming Using 'C' Language OR** **C) Acoustics and Entertainment Physics**	**Elective course**	**04**	**100**	**03**
PHY -303	**Any ONE of the following** **A) Systematic Materials Analysis OR** **B)Microprocessor and its Applications OR** **C) Communication Electronics**	**Skill Course**	**04**	**100**	**03**
Semester III : Practical Courses					
PHY -304	**Special Laboratory I**	**Core course**	**04+04**	**100**	**06**
PHY -305	**Project Work-I(Literature Survey, Definition of Problem, Experimental work, Oral etc.)**	**Skill course**	**04+04**	**100**	**06**
AC-301A/B/C/D	**Choose one out of Four (AC-301A-** Computer Skills **/ AC-301B -** Cyber Security**/ AC-301C-** Seminar + Review Writing **/ AC-301D-** Biostatistics**) from Technology + Value Added Courses**	**Audit course**	**02**	**100**	
Semester IV : Theory Courses					
PHY -401	**Nuclear Physics**	**Core course**	**04**	**100**	**03**
PHY -402	**Any ONE of the following** **A) Nanomaterials: Synthesis, Properties and Applications OR** **B) LASER and it's Applications OR** **C) Astrophysics**	**Core course**	**04**	**100**	**03**
PHY -403	**Any ONE of the following** **A) Renewable Energy Sources OR** **B) Microwave: Theory and Applications OR** **C) Environmental Physics**	**Elective course**	**04**	**100**	**03**
Semester IV : Practical Courses					
PHY -404	**Special Laboratory II**	**Core course**	**04+04**	**100**	**06**
PHY -405	**Project Work-II(Characterization, Analysis of Result, Conclusions, Project Report, Oral etc.)**	**Skill based**	**04+04**	**100**	**06**
AC-401A/B/C/D	**Choose one out of Four (AC-401A-**Human Rights **/ AC-401B –Current Affairs / AC-401C-** Seminar + Review Writing **/ AC-401D -** Intellectual Property Rights (IPR)**) from Professional and Social + Value Added Courses**	**Audit course**	**02**	**100**	

PHY– 301: Atomic and Molecular Physics		
	Course description: This course is aimed at introducing the fundamentals of Atomic and Molecular Physics to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Atomic and Molecular Physics. 2. To provide the knowledge and methodology necessary for solving problems in Physics. 3. The course also involves the related experiments based on the theory.	
Unit 1	**Atomic spectra:** Introduction, origin of hyperfine structure, hyperfine structure of two or more valence electrons, Zeeman Effect in hyperfine structure, Back Goudsmit effect in hyperfine structure. **(H-14, M-17)**	**14 L**
Unit 2	**Rotational Spectra:** Classification of molecular spectra (pure rotational spectra, Rotation-vibration spectra, visible and UV spectra),Types of molecules: Diatomic linear symmetric top, asymmetric top and spherical top molecules, Introduction to rotational spectra, relative intensities of spectral lines, rotational spectra of rigid and non-rigid molecules through microwave spectroscopy, Determination of moment of inertia and bond length from rotational spectra. **(H-10, M-12)**	**10 L**
Unit 3	**Vibrational spectra:** Anharmonic oscillator, deduction of molecular properties from vibrational spectra of diatomic molecules. **(H-4, M-5)**	**04 L**
Unit 4	**Rotation-Vibrational spectra:** Coupling of rotation and vibration, rotation-vibration spectra, selection rules and transitions for the vibrating rotator, intensities in rotation and irrotational spectra, parallel and perpendicular bands of linear molecules, isotope effect in vibrational rotational spectra. **(H-5, M-6)**	**05 L**
Unit 5	**Electronic spectra of Diatomic molecules**: Electronic energy curves, potential energy curves, stable and unstable molecular states, vibrational structure of electronic spectra, general formula, graphical representation, rotational structure of electronic spectra, P,Q,R branches of band, Band head formation, shading of bands: fortrat diagram, intensities in electronic – vibrational bands structure, Frank Condon principle. **(H-7, M-07)**	**07 L**
Unit 6	**RAMAN spectra:** Raman effect, quantum theory, Molecular polarizability, Pure rotational Raman spectra of diatomic molecules, vibration rotation Raman spectrum of diatomic molecule, intensity alternations in Raman spectra of diatomic molecules, applications of IR & Raman spectroscopy in the structure determination of simple molecules, polarization of Raman lines. **(H-7, M-7)**	**07 L**
Unit 7	**NMR spectroscopy:** Resonance Technique: NMR – nuclear spin magnetic moment, interaction of nuclear magnet with external field. Quantum description of N.M.R, NMR spectrometer, Chemical shift, spin – spin interaction, Application of NMR spectroscopy. **(H-5, M-6)**	**05 L**

Suggested Readings: / References:

1. Molecular Spectra & Molecular Structure: G. Herzberg, Vol. 1 & 2 (Von no strand Co. Inc 1965)
2. Fundamentals of Molecular Spectroscopy: C.B. Banwell.
3. Atomic and Molecular Spectra: Rajkumar
4. Fundamental of molecular spectroscopy: Raymond Chang, McGraw Hill-Kogakusha Ltd, London 1971.
5. Introduction to IR & Raman spectroscopy: Calthup, Daiy& Wimberley, Academic press1964.
6. Spectroscopy Vol I & II: Edited by B.P. Stranghan& S. Walker.
7. Spectroscopy and Molecular Structure: C. W. King Holt Reinhardt & Winston Inc. 1964.
8. Atomic Spectra – H. E. White
9. Physical Methods in Inorganic Chemistry – Drago
10. Physical Chemistry – Puri, Sharma, Patharia.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C301.1	After successful completion of the course, the student is expected to : know about different atom model and will be able to differentiate different atomic systems, different coupling schemes and their interactions with magnetic and electric fields.	
C301.2	Have gained ability to apply the techniques of microwave and infrared spectroscopy to elucidate the structure of molecules.	
C301.3	• Be able to apply the principle of Raman spectroscopy and its applications in the different field of science & Technology. • To become familiar with different resonance spectroscopic techniques and its applications. • To find solutions to problems related different spectroscopic systems.	

M.Sc. Part II Semester III (Physics): Elective Course (Select only one)

PHY-302(A): Materials Synthesis and Preliminary Analysis		
Unit 1	**Nucleation , Growth of Thin Films and Single crystal:** Condensation, Langmuir-Frankel theory of condensation. Theories of nucleation: Capillarity model, Atomistic model, Various stages of growth. Types thin film deposition techniques (list only**).** **(H-5, M-7)** **Single crystals:** Importance of growing single crystals and their uses, Thermodynamic principles and crystal growth equilibrium. Theory of crystal growth, Nucleation, Growth of single crystal by water solution method, growth by Gel method, growth by Flux method, Hydrothermal growth. **(H-5, M-7)**	10 L
Unit 2	**Physical Vapour Deposition Techniques:** **Thermal evaporation:** General considerations, evaporation methods: Resistance heating, Flash evaporation, R.F. heating, Electron beam (e-beam) heating, Molecular Beam Epitaxy (MBE**).** **(H-6, M-7)** **Sputtering:** Cathodic sputtering- Sputtering process, glow discharge sputtering pressure, Deposit distribution, current and voltage dependence, cathode, contamination problem, Deposition control, Sputtering variants, Low pressure sputtering: Magnetic field, Assisted(triode)sputtering, R.F. sputtering, Ion-beam sputtering. Reactive sputtering. **(H-6, M-7)**	12 L
Unit 3	**Chemical vapour deposition Techniques:** Principle, chemical reactions used. Pyrolysis (Thermal decomposition), Hydrogen reduction, Halide disproportionation, Transfer reactions, polymerization**.** **(H-4, M-5)**	04 L
Unit 4	**Chemical Bath Deposition Technique:** **Electode less deposition:** Mechanisms of chemical bath deposition. Introduction, Nuclean, Adhesion and film growth processes in Ion-by-Ion mechanism, Hydroxide cluster mechanism, complex decomposition mechanism. **(H-5, M-5)** **Chemical Spray Method:** Nucleation and growth process in film deposition, General idea of air pressure spray pyrolysis, Ultrasonic spray pyrolysis to prepare nanostructured films. **(H-5, M-5)**	10 L
Unit 5	**Thick film deposition technique:** Fundamental aspect of the process, Design aids, Screens, Substrate materials, Screen printing, Firing process, Components and network: Passive components, active components, Assembly, packaging and testing:	08 L

	soldering methods for component attachment, wire bonding, packaging, testing. **(H-8, M-7)**	
Unit 6	**Thickness measurement and Electrical Properties of films:** **Thickness measurement:** Optical interference technique, Multiple beam interferometry, Quartz crystal microbalance, Stylus (Talyestep) method. **(H-4, M-5)** **Electrical Properties:** Electrical conductivity of bulk, thin and thick films, two probe, Van-der Pauw and Four probe methods, Hall measurements, TEP measurements. **(H-4, M-5)**	**08 L**
Suggested Readings: References: 1. Thin Film Phenomenon, K.L. Chopra, McGraw Hill, 1969. 2. Hand book of Thin Film Technology L.I. Maissel & R.Glang, McGraw Hill, 1970. 3. Thin Film Processes: J.L. Vossen and W. Kern, Academic Press, 1978. 4. Thin Film Fundamentals, A.Goswami, New Age International Publishers. 5. Chemical Solution Deposition of Semiconductors Films : Gary Hodes- Weizmann Institute of Science, Rehorot, Iszael. New York-Basar. 6. The materials science of Thin Films: M.Ohring Academic Press,1992. 7. Active and Passive Thin Film Devices: T.J.Coutts, Acadmeic Press 1978. 8. An Introduction to Physics and Technology of Thin Films : A Wegendristel and Y.Wang, World Scientific 1994. 9. Handbook of Sensor and Actuators- Thick Film Sensors- Edited by M.Prudenziati, Elsevier (1994), Vol. I, Series editor S. Middelhoek.		

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C302.A.1	After successful completion of the course, the student is expected to : know about Films Thin Deposition Techniques	
C302.A.2	Have gained ability to apply the techniques of Chemical vapour deposition Techniques , Principle and chemical reactions	
C302.A.3	The students will know the Mechanical response of Materials under • Chemical Spray Method: Nucleation and growth process in film deposition. • Thickness measurements. • Thick film deposition technique. • Gel method, growth by Flux method, Hydrothermal growth. Electrical Growth of single crystal by water solution method	

PHY-302(B): Computational Methods and Programming Using 'C' Language		
	Course description: This course is aimed at introducing the fundamentals of Computational Methods and Programming Using 'C' Language to the students. **Course objectives:** 1) To impart knowledge of basic concepts in Computational Methods and Programming Using 'C' Language and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. **3)** The **graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.**	
Unit 1	**'C ' Language:** a) Review of C language for preparing and running 'C'programs. **(H-5, M-6)**	**05 L**

	b) Pointers: The concepts of pointers, The address operator, pointer arithmetic, pointers as function parameters, pointers and arrays, Dynamic storage allocation. **(H-4, M-4)**	**04 L**
	c) Structures and Unions: Declaration and period operator, structure initialization, structure and arrays, structure and functions, structure and pointers, structure within structure, Unions, Rules to use unions. **(H-4, M-4)**	**04 L**
	d) File handling: Opening and closing a data file, creating a data file, processing a data file. **(H-3, M-4)**	**03 L**
Unit 2	**Numerical methods:** In the following topics on numerical methods, students are expected to write programs using' C' language as well as perform numerical calculations using electronic calculators and mathematical tables. **a) Iterative methods to obtain roots of equations:** The method of successive bisection, false position method, Newton Raphson method. Derivation of formula and advantages as well as limitations of these methods solve each other. **(H-7, M-9)**	**07 L**
	b) Interpolation: Definition of Interpolation and extrapolation, finite differences, Interpolation with equally spaced and unevenly spaced points. Lagrange's interpolation, curve fitting, polynomial least squares and cubic spline fitting. **H-8, M-9)**	**08 L**
	c) Numerical Integration: Derivation and application of Trapezoidal, Simpson1/3 and Simpson' s 3/8 th rule. **(H-8, M-9)**	**08 L**
	d) Solution of simultaneous line are equations: Gauss elimination method, pivotal condensation, Gauss Seidal method. **(H-7, M-9)**	**07 L**
	e) Solution of first order differential equation: Euler's method, Runge-Kutta methods. **(H-6, M-6)**	**06 L**
Suggested Readings: References: 1. The 'C' Programming Language: Kernighan B.W. & Ritchie D.M.(Prentice Hall India Pvt. Ltd.). 2. Letus 'C': Yashwant Kanetkar (BPB Publications). 3. Schaum's outline of theory and problems of programming with 'C': Gottfried B.S. (Tata McGraw Hill Publishing Co. Ltd.). 4. Programming in ANSIC (IIndEdition)-E. Balagurusamy (Tata McGraw Hill Publishing Co. Ltd.) 5. The C language Trainer with C graphics and C++ -J.Jayasri (New Age International Pvt. Ltd. New Delhi.) 6. The spirt of 'C'–Mullish Cooper (Jaico Publishing Co. New Delhi). 7. Programming in ANSIC–Ramkumar (Tata McGraw Hill). 8. Introductory methods of Numerical Analysis-S.S. Sastry. 9. Numerical methods for engineers with programming and software applications-Steven C Chapra, Raymond P. Canale. (McGraw Hill). 10. Numerical Methods problems and solutions– M.K..Jain, S.R.K. Iyengar, R.K. Jain (Wiley Eastern Ltd). 11. Computer Oriented Numerical Methods – V. Rajaraman (Prentice Hall India Pvt Ltd.).		

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C302.B.1	After successful completion of the course, the student is expected to : know about Computational Methods and Programming Using 'C' Language and Applications	
C302.B.2	Have gained ability to apply the techniques of Computational Methods and Programming Using 'C' Language	
C302.B.3	The students will know the: • Review of C language for preparing and running 'C' programs. • Structures and Unions: Declaration and period operator, structure initialization. • Numerical Integration: Derivation and application of Trapezoidal, Simpson 1/3 and Simpson' s 3/8 th rule.	

PHY-302(C): Acoustics and Entertainment Physics		
	Course description: This course is aimed at introducing the fundamentals of Acoustics and Entertainment Physicsto the students. **Course objectives:** 1) To impart knowledge of basic concepts in Acoustics and Entertainment Physics and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. **3)** The **graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.**	
Unit 1	**Basic Principles:** Sound wave propagation ,Plane and Spherical waves, Plane wave equation(without derivation) ,Acoustic Intensity, Energy density, Acoustic impedance, **Decibel Scales :** Intensity level, Sound Pressure level, Sound power level, Loudness level, Equivalent continuous sound level, Laeqt, Perceived noise level LEPN, Noise pollution level, LNP. Human Speech and hearing mechanism, Threshold of audibility and feeling, Analogy among Electrical, Mechanical and Acoustical systems. **(H-10, M-10)**	**10 L**
Unit 2	Architectural Acoustics: Reverberation time, Decay of sound in a live room, Sabine Equation, Decay of sound in a dead room, Eyring's Journals, Optimum reverberation time, Coefficient of absorption and its measurement. Methods of measurement of reverberation time, Synthetic reverberation, Acoustical evaluation of Theatre/ auditoria/studios, Requirements for good acoustics of Theatre/Studios/auditoria. Sound reinforcement systems for auditoria. Amplifier power requirements, Audio delayers. **(H-10, M-12)**	**10 L**
Unit 3	**Loudspeakers:** Direct radiator dynamic loudspeakers, Horn loudspeakers, Directional characteristics, Equivalent circuits, Efficiency of loudspeakers, Special Purpose loudspeakers, Loudspeaker systems, woofer, midrange/squankes, tweeter, Crossover, networks, Loudspeaker Cabinets. **(H-6, M-6)**	**06 L**
Unit 4	**Microphones:** Carbon, Condenser, Moving coil dynamic and ribbon microphones, Microphone sensitivity, directional characteristics and applications, Calibration of microphones. **(H-6, M-6)**	**06 L**
Unit 5	**Sound Recording and Reproducing systems:** Basic requirements of a system for good quality recording and reproduction, Hi-Fi system, volume compressors. Viviters and expanders, Graphic equalizers. Monophonic and stereophonic sound reproducing systems. Magnetic tape sound recording and reproducing systems, Basic principles Analogue recording, Digital Audio tape, recording (DAT), Noise reduction in sound reproducing system-(I) Dolby A. B. System, Basic principles of compact Disc (CD), audio systems. **(H-10, M-12)**	**10 L**
Unit 6	**Musical Acoustics:** Characteristics of musical notes: Vibratio, tremolo, portamento, waveforms of typical musical tones, Basic principles of musical instruments, Electronic musical instruments, Computer music, MIDI and applications. **(H-5, M-7)**	**05 L**
Unit 7	**Ultrasonic and underwater acoustics:** Ultrasonic transducers-Principles and applications, Under water acoustics-Principles and applications of underwater transducers, underwater communication, SONAR. **(H-5, M-7**)	**05 L**

Suggested Readings: References:

1. Fundamentals of acoustics (2nd Ed.)-Kinsler and Frey.
2. Acoustics-W.W.Sets (Schwm series)
3. Music Physics and Engineering-HIF Olson
4. Acoustics Measurement-L.L.Bernek
5. Basic Acoustics-D.E.Hall

6. Technical Aspects of sound-(Vol. I) Richardson
7. Noise reduction-L.L.Bernk.
8. Audio Cyclopedia-H. Tremanic
9. Hand book of sound Engineers (New Audio cyclopedia)-G.M. Balloh(Ed.)
10. Acoustic techniques for the Home and Studio-F Alton Everest.
11. Design for good acoustics and noise control-J.E. Moore.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO
C302.C.1	After successful completion of the course, the student is expected to : know about Acoustics and Entertainment Physicsand Applications
C302.C.2	Have gained ability to apply the techniques of Acoustics and Entertainment Physics
C302.C.3	The students will know the : • Review of C language for preparing and running 'C' programs. • Structures and Unions: Declaration and period operator, structure initialization. • Numerical Integration: Derivation and application of Trapezoidal, Simpson 1/3 and Simpson' s 3/8 thrule.

M.Sc. Part II Semester III (Physics): Skill Course (Select only one)

PHY-303(A): Systematic Materials Analysis		
	Course description: This course is aimed at introducing the fundamentals of Systematic Materials Analysisto the students. **Course objectives:** 1) To impart knowledge of basic concepts in Systematic Materials Analysisand its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. **3)** The **graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.**	
Unit 1	**Characterization Techniques:** Importance of materials characterization, Classification of characterization techniques, Destructive and non-destructive techniques, Electromagnetic spectrum, Properties of electromagnetic radiation. **(H-6, M-6)**	**06 L**
Unit 2	**Infrared Spectroscopy:** Range of IR absorption, Requirements for infrared radiation Absorption, Theory of IR absorption Spectroscopy, Linear molecules, Spherical top molecules, Symmetric top molecules, Asymmetric molecules, Spectrophotometers, Application of IR Spectroscopy, Limitation of IR Spectroscopy. **(H-7, M-10)**	**07 L**
Unit 3	**UltraViolet & Visible Spectroscopy:** Regions of UV-Visible radiation, Colour and light absorption, The chromophore concept, Theory of electronic spectroscopy– orbital involved in electronic transitions, Laws of light absorption-Beer's and Lambert's laws, Instrumentation. U.V. spectrometer, Sample and reference cells, Applications of UV visible spectroscopy. **(H-10, M-12)**	**10 L**

Unit 4	**X-Ray Diffraction:** Crystalline state, X-ray diffraction processes, Preliminary discussion of powder and single crystal pattern and their information content, Structure determination, Particle size determination, Crystallography by diffraction of radiation other than X-ray, Applications of X-ray diffraction measurements. **(H-10, M-10)**	**10 L**
Unit 5	**Electron Microscopy:** Demerits of optical microscope at nano level, Need of Electron Microscopy, Why electrons? Electron Specimen interaction (Emission of secondary electrons, back scattered electrons, characteristics x-rays, transmitted electrons), Specimen interaction volume, resolution, Scanning electron microscope (SEM) Schematic diagram, Short details of each component, Field Emission Gun, Field Emission Electron Scanning electron microscope(FESEM),Principle of Image Formation, Energy Dispersive Analysis of X-rays (EDAX), Transmission electron microscope(TEM), Merits of TEM over SEM/FESEM. **(H-14, M-16)**	**14 L**
Unit 6	**Scanning Tunneling Microscopy:** An Introduction to Quantum Mechanical Tunneling, Basic Principles of STM, Two Modes of Scanning, Interpreting STM Images, and Applications of STM. **(H-5, M-6)**	**05 L**
Suggested Readings: References: 1. Elements of X-ray diffraction, B.D.Cullity, Addision-Wesely Publishing Co., USA. 2. SEM micro characterization of semiconductors, D.B. Holt, and D.C. Joy, Academic Press, New Delhi. 3. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw-Hill Publ. Delhi. 4. Instrumental methods of Analysis (Seventh Edition) H.H. Willard, L.L. Merritt, John A Dean, F.A. Settle CBS Publishers and Distributors, New Delhi-110002. 5. Introduction to Nanoscience and Nanotechnology, K.K. Chattopadhyay and A.N. Banerjee, PHI Pvt. Ltd., New Delhi- 110001. 5. Characterization of Materials, Volume1, & 2, Elton N. Kaufman, Wiley-Inter science. 6. Hand book of Microscopy for Nanotechnology, NanYao, Ahong LinWang, Kluwer Academic Publishers.		

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C303.A.1	After successful completion of the course, the student is expected to : know about Systematic Materials Analysis and Applications	
C303.A.2	Have gained ability to apply the techniques of Introduction to Characterization Techniques: Importance of materials characterization	
C303.A.3	The students will know the Mechanical response of Materials under • Infrared Spectroscopy. • Ultra Violet & Visible Spectroscopy: Regions of UV-Visible radiation. • Scanning Tunneling Microscopy: An Introduction to Quantum Mechanical Tunneling. • Crystalline state, Xray diffraction processes.	

PHY-303(B): Microprocessor and its Applications

	Course description: This course is aimed at introducing the fundamentals of **Microprocessor and its Applications** to the students. **Course objectives:**	

	1) To impart knowledge of basic concepts in Microprocessor and its Applications. 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**The 8086 Microprocessor:** Register organization of 8086, 8086 Architecture, Pin configuration, Physical Memory organization, General bus operation, I/O address capability, Special purpose activities, minimum and maximum mode of 8086 systems with timings. **(H-15, M-20)**	**15 L**
Unit 2	**Instruction set of 8086 and programming:** Addressing modes of 8086, Instruction set of 8086, Assembler directives and operators. Simple programs like addition of two numbers, BCD addition, find the largest number, addition of two 3 x 3 matrices, move the string of data, find the number of positive numbers and negative numbers from, a given series of signed numbers etc. **(H-17, M-20)**	**17 L**
Unit 3	**Special Architectural features:** Stack structure of 8086, Interrupts and interrupt service routine, Interrupt programming, Macros. (Programming is not expected). **(H-6, M-10)**	**06 L**
Unit 4	**Programmable Peripheral Devices and their Interfacing:** i] Programmable peripheral interface 8255, ii] Programmable Communication interface 8251USART, iii] Programmable DMA interface 8257, iv] Programmable interrupt Controller 8259. **(H-10, M-5)**	**10 L**
Unit 5	**32 bit Processor:** Features of 80386, 80486, 80586 (Pentium), MMX (Multimedia Extension) **(H-4, M-5)**	**04 L**
Suggested Readings: References: 1. Advance Microprocessor and Peripherals: A.K.Ray, K.M.Bhurchandi., Tata McGraw Hill, New Delhi. 2. Microprocessor and Interfacing: DauglasV.Hall, McGraw Hill International Edition. 3. Architecture, Programming and Design: Yu Cheng Liu,G.A.Gibson, 2ndEdition. PHI Publications.		

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C303.B.1	After successful completion of the course, the student is expected to : know about Microprocessor and its Applications	
C303.B.2	Have gained ability to apply the techniques of Programmable Peripheral Devices and their Interfacing	
C303.B.3	The students will know the Mechanical response of Materials under- • The 8086 Microprocessor: Register organization of 8086, 8086 Architecture. • 32 bit Processor: Features of 80386, 80486, 80586 (Pentium). • Instruction set of 8086 and programming: Addressing modes of 8086	

PHY-303(C): Communication Electronics

	Course description: This course is aimed at introducing the fundamentals of Communication Electronics to the students. **Course objectives:** 1) To impart knowledge of basic concepts in Communication Electronics and its applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of	

	areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Electronic Communication:** Importance of Communication, Introduction to Elements of communication systems and types of electronics communication (Simplex, Duplex, Analog, Digital, Base band and modulated signals) [kennedy]. **(H-3, M- 4)**	**03 L**
Unit 2	**Modulation Systems Amplitude Modulation:** (Spectrum of an Amplitude Modulated signal, Low level AM Modulator), Single Sideband (SSB) Modulation, Generation of SSB signal (Filter Method), Vestigial-Sideband (VSB) Modulation, Demodulation of AM Waves (Square-law Detectors, Linear Diode Detector) Frequency and Phase Modulation:- FM generation (Parameter Variation method), Frequency multiplication, FM Demodulation (Slope Detector) Pulse Modulation, Pulse Code Modulation (PCM), Pulse Amplitude Modulation (PAM), Time-Division Multiplexing (TDM), Pulse Time Modulation (PTM) [Roddy & Coolen]. **(H-11, M-12)**	**11 L**
Unit 3	**Radiation & Propagation of Waves Electromagnetic Radiation:** (Fundamentals of electromagnetic waves & effect of environment), Propagation of waves (Ground or surface waves, sky wave propagation- The ionosphere, space waves, Tropospheric scattering propagation, Extraterrestrial communications) [Kennedy]. **(H-7, M-8)**	**07 L**
Unit 4	**Antennas:** Antenna parameters- power gain, isotropic radiator, radiation resistance, directivity, directional gain, radiation parameter, polarization, effective apparatus, effective length, front to back ratio. Types of antenna- Half wave dipole (without mathematical derivation), Yagi & dish antenna. [Roddy & Coolen]. **(H-7, M-8)**	**07 L**
Unit 5	**Television Fundamental**: Introduction to TV, TV systems & standards, Black & White transmission & reception, Colour transmission & reception. [Kennedy] **(H-4, M-5)**	**04 L**
Unit 6	**Radar and Satellite Systems Fundamentals of RADAR system:** Block Diagram, Frequencies and Powers used in RADAR, RADAR performance Factors, Effects of Noise, Basic Pulse RADAR systems (Block Diagram and Description), Antenna and Scanning, Moving target Indication (Doppler Effect), Other RADAR systems (RADAR Beacons, Phased RADAR), RADAR applications. [Kennedy]; Orbital Satellites, Geostationary Satellites, Look Angles (angle of elevation, Azimuth angle), Satellite system Link Model (UP Link Model, Transponder, Down-Link Model) [Roddy] **(H-10, M-10)**	**10 L**
Unit 7	**An overview of Telecommunication:** History of Telecommunication, Telecommunication network, Internet, classification of data network, by spatial distance (WAN, MAN, LAN), by Cellular concept, Mobile Telephone communication [A. A. Gokhale] **(H-4, M-6)**	**04 L**
Unit 8	**Introduction To Fiber Optic Technology:** Introduction, Principle of light transmission in a fiber, losses in fiber, dispersion, light sources for fiber optics, photo detector, fiber optic communication system.[Roddy & Coolen] **(H-6, M-7)**	**06 L**

Suggested Readings: References:

1. Electronic communication System- Kennedy & Davis (Tata Mc-Graw Hill) 4th ed.
2. Electronic communication- Roddy & Coolen. (PHI) 3rd ed.
3. Satellite Communication- Dennis Roddy, (Mc-Graw Hill), 3rd ed. 9
4. Fiber Optic Communication- John Senior, (Prentice Hall International), 2nd ed.
5. Antenna & Wave Propagation- K. D. Prasad, (Satya Prakashan New Delhi)
6. Introduction to Telecommunication-Anu A Gokhale, (Cengage Learning) 2nded.
7. Electronic communication-Sanjeev Gupta (Khanna Publication, New Delhi).
8. Electronic communication: Fundamentals Through Advances-Wame Tomdsi (Prentice Hall Publications)

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C303.C.1	After successful completion of the course, the student is expected to :	

	know about Communication Electronics and Applications	
C303.C.2	Have gained ability to apply the techniques of Introduction to Elements of communication systems and types of electronics communication	
C303.C.3	The students will know the Mechanical response of Materials under • Modulation Systems Amplitude Modulation. • Radiation & Propagation of Waves of Electromagnetic Radiation. • Types of antenna- Half wave dipole. • Television Fundamental, Introduction to TV, TV systems. • Radar and Satellite Systems Fundamentals of RADAR system: Block Diagram, Frequencies and Powers	

M.Sc. Part II Semester III (Physics): Practical (Core course)

PHY -304: Special Laboratory I	
Course description: This course is aimed at introducing the fundamentals of Special Laboratory I to the students. **Course objectives:** 1. To impart knowledge of basic concepts in Special Physics II. 2. To provide the knowledge and methodology necessary for Practical problems in Physics. 3. The course involves the related experiments based on the Practical.	
Group A **Perform at least TEN experiments from the following**	
1	1. To measure the thermoelectric power of semiconductor. 2. Study of Haynes-Schokley experiment for determination of mobility and diffusion constant. 3. Measurement of thickness of thin film by Tolansky method. 4. Study of electron spin resonance spectrum for given sample and determination of Lande 'g' factor. 5. To record and analyze the spectral response of a given photo conducting sample. 6. Determination of resonance frequency of piezoelectric element. 7. Study of hysteresis of hard and soft ferrites. 8. Skin depth of electromagnetic radiation in Al. 9. Determination of Fermi energy in Cu. 10. Coherence & width of spectral lines using Michelson interferometer. 11. The Franck-Hertz experiment. 12. Absorption Spectrum Of Iodine Vapour. 13. Charge on an electron using spectrometer.
2	**Material Synthesis** 1. Deposition of metallic thin films by vacuum evaporation method and measurement of resistance/resistivity/ conductivity and TCR at different temperatures by the two probe/four probe method. 2. Deposition of thin films by spray pyrolysis method and thickness measurement by gravimetric method. 3. Measurement of reflectivity and transferability of thin films by using He-Ne laser. 4. Determination of refractive index of a transparent film by Abe's method. 5. Study of vacuum system to measure speed of rotary pump. 6. Pattern generation by Photolithography. 7. Electrical conductivity measurements in thick films. 8. Synthesis of CdS thin film by chemical bath deposition (CBD) method.

	9. Stress measurement of transparent conducting oxides (Newton's ring method) 10. Determination of band gap energy of a given sample using absorption/transmission spectra.
3	**Material Science:** 1. Study of phase transformation in a ferroelectric crystal. 2. Study of creep behaviour of Sn-Pb alloy. 3. Thermoluminescence of alkali halides. 4. Determination of diffusion coefficient of cobalt atoms in Gel medium. 5. Determination of crystal structure of given material by X-ray diffract meter. 6. Determination of grain size of a given sample by Scherer method. 7. Determination of direct and indirect band gap of a given materials by UV-visible spectroscopy. 8. Determination of inter atomic bond length in a diatomic molecule by studying rotational vibrational IR spectra. 9. Study of Beer Lamberts Law in absorption spectroscopy using IR spectroscopy. 10. Synthesis of conducting oxide films by pyrolysis method.
4	**Communication Electronics**: 1. Pulse amplitude modulation. 2. Pulse position modulation. 3. Pulse width modulation. 4. Study of delta modulation. 5. Characteristics of antenna. 6. Study of amplitude modulator and demodulator. 7. Study of frequency modulator. 8. Study of FSK modulator and demodulator. 9. Study of Digital multiplexer.
5	**Microprocessors:** 1. Square, Triangular and Ramp wave generator using microprocessor. 2. Interfacing an eight bit ADC with microprocessor. 3. Write a program for four digit hexadecimal counters. The counter should stop and resume counting by pressing a key. 4. Temperature measurement using ADC. 5. Read data through thumb wheel switches and display it on monitor and 7-segment display. 6. Write a program to control relay switches with a delay of 1 second. 7. Average the given set of data and display the result in decimal form. 8. Stepper motor speed control using microprocessor. 9. Read string through keyboard which is terminated by any specified character and reverse the string. 10. Read two digit hexadecimal number through key board and convert it into binary form. 11. Interrupt driven clock.(Ref. Ramesh S. Gaonkar Page No.376)
6	**Computational Methods & 'C' Language programming :** 1. Draw a flowchart and write a program to find the root of the equation f(x)=0 by Bisection method. 2. Draw a flowchart and write a program to find the root of the equation f(x)=0 by Newton Raphson method. 3. Draw a flowchart and write a program to find the root of the equation f(x)=0 by False position method. 4. Draw a flowchart and write a program to integrate the given function using Trapezoidal rule. 5. Draw a flowchart and write a program to integrate the given function using Simpson's 1/3 rule. 6. Draw a flowchart and write a program to integrate the given function using Simpson's 3/8 rule. 7. Draw a flowchart and write a program for fitting of a polynomial of degree n usingLagrange's Interpolation formula. 8. Draw a flowchart and write a program to solve given set of simultaneous equationsusing Gauss Elimination method.

	9. Draw a flowchart and write a program to solve given set of simultaneous equationsusing Gauss Seidal method. 10. Draw a flowchart and write a program to solve given differential equation usingEuler's simple method. 11. Draw a flowchart and write a program to solve given differential equation usingRungekutta method. 12. Draw a flowchart and write a program for finding the inverse of a givenmatrix./transpose of a matrix. 13. Implement strlen ( ), Stract ( ), Strcpy ( ), Strcmp ( ) using pointers. 14. Write a menu driven program to create, list, modify and calculate the student record details. Assume the file structure: Register No., Subject 1 mark, Subject 2 mark and Subject 3 mark.
7	**Biomedical Instrumentation** : 1. ECG preamplifier- instrumentation amplifiers design & testing. 2. Active filters for bio-signals-design & testing. 3. Wave shaping circuits for cardiac pacemaker. 4. Acoustic impedance measurement. 5. Recording of action potentials with extra cellular electrodes. 6. ECG signal recording with surface electrodes. 7. Blood pressure measurement with transducer/pressure differentiation circuits.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C304.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Special Physics II course to real life problems.	
C304.2	2. Understanding of the Special Physics II course which will create scientific temperament..	
C304.3	Students will have hand on experience of Practical Based on : • Measurement of thickness of thin film by Tolansky method. • Franck-Hertz experiment. Magnetic susceptibility. • Material Synthesis. • Material Science. • Communication Electronics. • Microprocessors. • Computational Methods & 'C' Language programming. • Biomedical Instrumentation	

PHY-305 M. Sc. Project – I(Skill Base)

	Course Objectives: 1. To give exposure to the students to research culture and technology. 2. To introduce students how to select a research topic, plan, perform experiments, collect data and analyse the data. 3. To foster self-confidence and self-reliance in the students as he/she learns to work and think independently.	
	Activities: 1. To display the list of 'project titles' on notice board. 2. To organize a meeting of project supervisors' and students for discussion about	

	projects. 3. To finalize the project titles so as to match student's particular interest. 4. Survey of the Literature. 5. To set the experiment/to start Preliminary Experimental work. 6. Internal examination. The guide should regularly monitor the progress of the project work. **ASSESSMENT OF PROJECT TERM WORK (FIRST TERM)**: Student should submit a Progress Report on the work done by him/her during the First Phase of the project including following points; 1. Project Selection, 2. Literature Search Strategy, 3. Literature Review, 4. Project Planning. Student will have to give a seminar on the above topics. **Internal examination (40 marks): Components of internal assessment: Project Selection (05 Mark.) Literature Collection and Literature Revive(10 marks) planning and design (10 marks), Submission of progress report (10 marks), and regular attendance (5 marks) recorded: Research Supervisors** **External Examination system should be held on fourth semester with assessment of PHY-405.**	

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C305.1	Conceive a problem based on published research and carry out comprehensive survey of literature	**4**
C305.2	Plan and carry out task in given framework of dissertation and present the work in written and viva	**6**
C305.3	Use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.	**6**
C305.4	Learn handling of instruments, use of chemicals and how to conduct the experiments	**3**
C305.5	Learn how to present the project in power point and answer the queries to examiners as well as science of writing	**6**

M.Sc. Part II Semester III Physics: Audit Courses

AC-301(A): Computer Skills **(Technology + Value added Audit course; Practical; 2 Credits)** **(Optional: Campus + Program level)**		
Course Objectives (CObs): • To inculcate different daily useful computer skills among students.		
Unit 1	**Elements of Information Technology** 1.1 Information Types: Text, Audio, Video, and Image, storage formats. 1.2 Components: Operating System, Hardware and Software, firmware. 1.3 Devices: Computer, Mobile Phones, Tablet, Touch Screen, Scanner, Printer, Projector, smart boards. 1.4 Processor & Memory: Processor functions, speed, Memory types: RAM /ROM /HDD /DVD-ROM/Flash drives, memory measurement metrics.	**2 H**
Unit 2	**Office Automation-Text Processing** 2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View,	**5 H**

	Reading Layout View. 2.2 Working with Files: Create New Documents, Open Existing Documents, Save Documents to different formats, Rename Documents, Close Documents. 2.3 Working with Text: Type and Insert Text, Highlight Text, Formatting Text, Delete Text, Spelling and Grammar, paragraphs, indentation, margins. 2.4 Lists: Bulleted and Numbered List. 2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Move and Resize Tables, Moving the order of the column and/or rows inside a table, Table Properties. 2.6 Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents. 2.7 Paragraph Formatting, Paragraph Attributes, Non-printing characters. 2.8 Types of document files: RTF, PDF, DOCX etc.	
Unit 3	**Office Automation-Worksheet Data Processing** 3.1 Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets. 3.2 Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows and Columns, Selecting Cells, Moving and Copying Cells. 3.3 Formulas and Functions: Formulas, Linking Worksheets, Basic Functions, AutoSum, Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill, Deleting Rows, Columns, and Cells. 3.4 Charting: Chart Types, drawing charts, Ranges, formatting charts.	**5 H**
Unit 4	**Office Automation- Presentation Techniques and slide shows** 4.1 Create a new presentation, AutoContent Wizard, Design Template, Blank Presentation, Open an Existing Presentation, PowerPoint screen, Screen Layout. 4.2 Working with slides: Insert a new slide, Notes, Slide layout, Apply a design template, Reorder Slides, Hide Slides, Hide Slide text, Add content, resize a placeholder or textbox, Move a placeholder or text box, Delete a placeholder or text box, Placeholder or Text box properties, Bulleted and numbered lists, Adding notes. 4.3 Work with text: Add text and edit options, Format text, Copy text formatting, Replace fonts, Line spacing, Change case, Spelling check, Spelling options. 4.4 Working with tables: Adding a table, Entering text, Deleting a table, Changing row width, Adding a row/column, Deleting a row/column, Combining cells, Splitting a cell, Adding color to cells, To align text vertically in cells, To change table borders, Graphics, Add clip art, Add an image from a file, Save & Print, slide shows, slide animation/transitions.	**6 H**
Unit 5	**Internet & Applications:** 5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing the Internet, Brief history, Browsing the Web, Hypertext and hyperlinks, browsers, Uniform resource locator 5.2 Internet Resources: Email, Parts of email, 5.3 Protecting the computer: Password protection, Viruses, Virus protection software, Updating the software, Scanning files, Net banking precautions. 5.4 Social Networking: Features, Social impact, emerging trends, issues, Social Networking sites: Facebook, Twitter, linkedin, orkut, online booking services 5.5 Online Resources: Wikipedia, Blog, Job portals, C.V. writing 5.6 e-learning: e-Books, e-Magazines, e-News papers, OCW(open course wares): Sakshat (NPTEL) portal, MIT courseware	**4 H**
Unit 6	**Cloud Computing Basics** 6.1 Introduction to cloud computing 6.2 Cloud computing models: SAS, AAS, PAS 6.3 Examples of SAS, AAS, PAS (Drop Box, Google Drive, Google Docs, Office 365 Prezi, etc.)	**3 H**
Suggested readings: 1. TCI, "Introduction to Computers and Application Software", Publisher: Jones & Bartlett Learning, 2010, ISBN: 1449609821, 9781449609825 2. Laura Story, Dawna Walls, "Microsoft Office 2010 Fundamentals", Publisher: Cengage Learning, 2010, ISBN: 0538472464, 9780538472463		

3. June Jamrich Parsons, Dan Oja, "Computer Concepts Illustrated series", Edition 5, Publisher Course Technology, 2005, ISBN 0619273550, 9780619273552
4. Cloud computing online resources

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301A.1	Identify their lacunas about some computer skills and try to overcome the same.	**2**
AC301A.2	Practice the learned computer skills in real life and do their jobs more effectively.	**3**

AC-301(B): Cyber Security

(Technology + Value added Audit course; Practical; 2 Credits)
(Optional: Campus + Program level)

Course Objectives (CObs):

- To make students aware of different daily useful cyber security skills/rules.

Unit 1	**Networking Concepts Overview** Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet.	**3 H**
Unit 2	**Security Concepts** Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux.	**7 H**
Unit 3	**Security Threats and vulnerabilities** Overview of Security threats, Hacking Techniques, Password Cracking, Types of password attacks, Insecure Network connections, Wi-Fi attacks & countermeasures, Information Warfare and Surveillance. Cyber crime: e-mail related cyber crimes, Social network related cyber crimes, Desktop related cyber crimes, Social Engineering related cyber crimes, Network related cyber crimes, Cyber terrorism, Banking crimes.	**7 H**
Unit 4	**Cryptography** Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure.	**5 H**
Unit 5	**System & Network Security** System Security: Desktop Security, email security: PGP and SMIME, Web Security: web authentication, Security certificates, SSL and SET, Network Security: Overview of IDS, Intrusion Detection Systems and Intrusion Prevention Systems, Overview of Firewalls, Types of Firewalls, VPN Security, Security in Multimedia Networks, Fax Security.	**3 H**
Unit 6	**OS Security** OS Security Vulnerabilities updates and patches, OS integrity checks, Anti-virus software, Design of secure OS and OS hardening, configuring the OS for security, Trusted OS.	**2 H**
Unit 7	**Security Laws and Standards** Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its	**3 H**

	amendments.	

Suggested readings:

1. Skills Factory, Certificate in Cyber Security, Text Book Special edition, Specially published for KBC NMU, Jalgaon.
2. BPB Publication, "Fundamentals of Cyber Security", Mayank Bhushan, Rajkumar Singh Rathore, Aatif Jamshed.
3. Create Space Independent Publishing Platform, "Cyber Security Basics", Don Franke, ISBN-13: 978-1522952190ISBN-10: 1522952195.
4. Online references.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301B.1	Practice learned cyber security skills/rules in real life.	**3**
AC301B.2	Provide guidance about cyber security skills/rules to their friends, parents and relatives.	**2**

AC-301(C): Seminar + Review Writing

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant biological information.

Writing a Scientific Literature Review:

- Choosing a topic, Deciding the scope of topic, Significance and impact of scientific problem being addressed, Relevance to subject, current issues and social relevance, Strengths and limitations of the study, Enticing broad audience.
- Literature Survey and Information to consider in the review:
  - Literature search using authentic library resources (print and non-print, digital and virtual) for Almanacs, Encyclopaedia, Dissertations, Theses, Research papers, Review articles, Reference/ Textbooks, and Popular articles (INFLIBNET, Google Scholar, Pub Med, Highwire, Google patents, Indian patent database, etc.).
  - Analyzing the literature quality (indexing, peer review, citations, journal impact factor, etc.).
- Deciding a writing approach (theoretical, experimental, interpretive, clinical, etc.), prepare the highlights and drawing important conclusion from literature.
- Sections to include and tips for writing them: Abstract, Introduction, Body, Discussion, Conclusion, References.
- Reference styles (MLA, APA, etc.), Use of bibliography/ reference/ citation managers and generators (Reference Manager, EndNote, RefWorks, Mendeley, Zotero, Qiqqa, etc.).
- Ethics of publication: Approval and consent, Data ethics (accuracy, falsification, fabrication, and confidentiality), Plagiarism and self-plagiarism, collaborative authorship, conflict of interest, legal consequences.
- Content similarity detection, Use of anti-plagiarism services (Urkund, iThenticate, Turnitin, Copyscape, Grammarly, etc.).

Seminar Activity:

- Students are encouraged to deliver seminars on the topics of research, preferably published research paper in a reputed and indexed journal to develop presentation skills and enable to build confidence which will lead them to read different themes and enhance their scientific approach and knowledge assimilation abilities.
- Presentations must be created and presented by students using digital platform using a suitable software in the presence of student audience and faculty for evaluation.

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301C.1	Retrieve, analyses, comprehend the scientific information on a given topic and derive logical inferences.	**4**
AC301C.2	Compile the scientific information on a topic, verify for similarity index or plagiarism.	**2**
AC301C.3	Deliver the interactive presentation of scientific data before audience and participate in open discussion with confidence.	**2**

AC-301(D): Biostatistics

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To learn basic statistical concepts/methods and their applications in biological processes and experiments.

Unit 1	**Descriptive Statistics and Presentation of Data** • Types of Data: qualitative and quantitative data; nominal and ordinal data; discrete and continuous data; frequency and non-frequency data, Different types of scale - nominal, ordinal, ratio and interval. • Analysis of univariate Quantitative Data: Concepts of central tendency or location, dispersion, skewness and kurtosis, measures of dispersion: range, quartile deviation, variance, standard deviation. • Analysis of bivariate Data: measures of association, correlation. • Presentation of Data: construction of tables with one or more factors of classification, diagrammatic and graphical representation of non-frequency data, frequency distributions, histogram. • Graphical presentation of data through bar graph, line graph, pie chart, histogram, dot plot, box-plot, multiple line/bar graphs etc.	**8 H**
Unit 2	**Correlation and regression** • Bivariate data: scatter diagram, coefficient of determination, rank correlation: Spearman's rank correlation coefficient. • Meaning and concept of regression, fitting of simple linear regression and quadratic regression in single predictor variable. • Multivariate data: multiple regression, coefficient of determination, R-square and its interpretation, testing significance of predictor variables.	**8 H**
Unit 3	**Testing of hypothesis and basic statistical designs** • Introduction of methods of sampling. • Statistical hypothesis, problem of testing of hypothesis, simple and composite hypothesis, types of errors, p-value, conclusions in hypothesis testing. • Statistical tests: one sample t-test, paired t-test, test for proportions, chi-square test for testing independence/association of attributes. • Design of experiments: introduction to basic terms of design of experiments, standard designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), concept of ANOVA, F-test in ANOVA, interpretation of results from ANOVA.	**8 H**
Unit 4	**PRACTICALS (Emphasis on examples from Biological Sciences)** • Based on graphical Representation. • Based on measures of Central Tendency & Dispersion. • Based on Distributions Binomial Poisson Normal.	**6 H**

	• Based on t, f, z and Chi-square. • Based on basic statistical designs.	

Suggested readings:

1. Le CT (2003) Introductory Biostatistics. 1st edition, John Wiley
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
5. Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301D.1	Describe and identify data generated from biological processes and experiments.	**1**
AC301D.2	Use summary statistics: measures of central tendency, measures of dispersion with their interpretations for explain the data more effectively through graphical tools.	**3**
AC301D.3	Apply knowledge of correlation, regression analysis and testing of hypothesis to real life data and understand their interpretation.	**3**

PHY– 401: Nuclear Physics		
	Course description: This course is aimed at introducing the fundamentals of Nuclear Physics to the students. **Course objectives:** 1) To impart knowledge of basic concepts Nuclear Physics and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**General Properties of Nuclei:** Constituents of nucleus and their properties; packing fraction; mass defects; binding energy; average binding energy and its variation with mass number; concept of parity; magnetic dipole moment; electric quadruple moment; problems. **(H-5, M-6)**	**05 L**
Unit 2	**Nuclear Model:** Types of nuclear models (list only); Liquid drop model: assumptions, semi empirical mass formula, achievements, failure and limitations of liquid drop model; Shell model, basic assumptions, nuclear magic numbers, experimental evidences of nuclear magic number and its significance, achievements and limitations of shell model; rules for angular momenta and parity of nuclear ground state; prediction of angular momenta and parity of nuclear ground state; nuclear energy level and their applications; problems. **(H-7, M-8)**	**07 L**
Unit 3	**Nucleon – Nucleon Interaction:** The deuteron problem; radius of deuteron; magnetic dipole moment and electric quadruple moment of deuteron; Nature of interactions: electromagnetic, weak interactions and hadronic interactions; nucleon - nucleon scattering; scattering cross section; Low-energy neutron proton scattering and proton-proton scattering, High energy neutron-proton and proton -proton scattering. **(H-8, M-8)**	**08 L**
Unit 4	**Interaction of charged particle and EM radiations with matter:** Energy loss of charged particles (Bohr formula); stopping power; range and straggling; Cerenkov radiation; gamma (γ) ray interaction through matter; law of absorption of γ – rays; linear and mass absorption coefficient; the photoelectric process; Compton effect; pair production and annihilation of electron – positron pair; Dirac's theory of pair production; problems. **(H-14, M-18)**	**14 L**
Unit 5	**Particle accelerators and Radiation Detectors:** Classification of accelerators; Van-de-Graft generator; linear accelerator; synchrocyclotron; pellet on; microtone; types of detectors; scintillation detector and photomultiplier tube (PMT); semiconductor detector; bubble chamber; cloud chamber; spark chamber. **(H-10, M-12)**	**10 L**
Unit 6	**Elementary Particle Physics** Introduction; classification of elementary particles; particle interactions; elementary particle and their intrinsic quantum numbers (charge, Lepton number, Baryon number, iso-spin, strangeness etc.); conservation laws; Invariance under charge; Electrons and Positrons, Protons and antiprotons, Neutrons and antineutrons, Neutrinos and antineutrinos; Quark: assumption and properties; Quark model; colour of a Quark and its importance. **(H-8, M-8)**	**08 L**

Suggested Readings: Reference Books:

1. Concepts of Nuclear Physics: B.L. Choen, Tata McGraw Hill.
2. Subatomic Physics: Franenfelder and Hanley, Prentice Hal.l
3. Nuclei and Particles: E. Segre.
4. Atomic Nucleus: R. C. Evans.
5. Basic Nuclear Physics: B.N. Shrivastava.
6. Introduction to Nuclear Physics: David Halliday.
7. Introduction to Nuclear Physics: Herald Enge. 30.
8. Nuclear Physics: Irving Kaplan.
9. Elements of Nuclear Physics: M.L. Pandya and Yadav.
10. An Introduction to Nuclear Physics: Bhide & Joshi.
11. Nuclear Physics: D.C. Tayal.

12. Radiation Detectors By Ramamurthy and Kapoor.
13. Introduction to Nuclear Physics By S. B. Patel.
14. Radiation Detection Techniques By Price.
15. Introduction to Nuclear Techniques By Knoll.

Course Outcomes (Cots):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C401.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Nuclear Physics course to real life problems.	
C401.2	2. Understanding of the Nuclear Physics course which will create scientific temperament.	
C401.3	Students will have hand on experience of theory Based on : • General Properties of Nuclei Constituents of nucleus and their properties. • Interaction of charged particle and EM radiations with matter Energy loss of charged particles. • Particle accelerators and Radiation Detectors Classification of accelerators; Van-de-Graft generator etc. • Elementary Particle Physics Introduction; classification of elementary particles; particle interactions. • Nucleon – Nucleon Interaction The deuteron problem.	

M.Sc. Part II Semester IV (Physics): SkillCourse(Select only one)

	PHY- 402 (A): Nanomaterials: Synthesis, Properties and Applications	
	Course description: This course is aimed at introducing the fundamentals of Nanomaterials: Synthesis, Properties and Applications to the students. **Course objectives:** 1) To impart knowledge of basic concepts Nanomaterials: Synthesis, Properties and its applications 2) The graduates will have knowledge of fundamental concepts and principles in a variety of areas of Nanoscience and Nano Technology with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques related to Nanomaterials.	
Unit 1	**Introduction:** Definition of, Nanomaterials-Definition and Necessity, Properties of Nanoscale, Comparison of Nanomaterials with bulk material, What is nanotechnology? What should we expect from it? Introduction to low dimensional structures: Quantum wells, Quantum wires and Quantum dots, Nanoclusters and Nanocrystals. Quantum mechanics for low dimensional structures: Electron confinements, Schrodinger equation for particle in one dimensional box, Density of states, Density of states for a zero dimensional quantum dots, Density of states for 1-D Quantum wire, Density of states for two dimensional thin films, Density of states for a particle in three dimensional box. **(H-10, M-12)**	**10 L**
Unit 2	**Techniques for synthesis of nanomaterials**: I. Physical methods: High energy ball milling, Physical vapour deposition: Resistive heating, LASER ablation, sputter deposition.	**20 L**

	II Chemical methods: Colloid, Synthesis of colloids, Growth of nanoparticles, synthesis of metal nanoparticles by colloidal route, synthesis of semiconductor nanoparticles by colloidal route, Langmuir-Blodgett method, Sol-gel method, Synthesis of metal oxides by sol-gel technique. III Biological, methods: Introduction, Synthesis of nanoparticles using Microorganisms, Synthesis using plant extracts, Use of proteins and Temples like DNA. IV Hybrid techniques: Chemical vapor deposition, Ultrasonic automization, Electrochemical. V Nanolithography: Lithography using photons, using particle beams, Scanning probe lithography. **(H-20, M-24)**	
Unit 3	**Synthesis of some special Nanomaterials**: Synthesis of magnetic nanoparticles, Magnetic properties-Super paramagnetic materials, processes for their biocompatibility, applications of magnetic nanoparticles. Carbon nanotubes: Synthesis of SWNT and MWNT, Applications of SWNT and MWNT. **(H-6, M-08)**	**06 L**
Unit 4	**Nanophotonics**: Foundation for nanophotonics, Synthesis of metal chalcogenides (S, Se and Te) nanocomposites, photo conducting and photoluminescence properties of metal chalcogenides, photoconductivityofnanorods. **(H-6, M-08)**	**06 L**
Unit 5	**Characterization of Nanomaterials**: X-ray diffraction- structural studies, Interpretation of broadening of peaks, Electron microscopy (FESEM/TEM)- Micro structural properties (Topographical and morphological studies) Scanning Tunneling Microscopy-Determination of surface structures UV-VIS- optical properties related to Quantum confinement, Electrical and thermal transport properties, Plasmon resonance peaks and blue shiftatNanoscale. **(H-10, M-08)**	**10 L**

Suggested readings: Reference Books: /

1. Nanotechnology: Michel Kohler, Wolfgang Fritzsche.
2. Nanomaterials: Synthesis, Properties and Applications: A.S. Edelstein and R.C. 20 Cammarata, Institute of Physics Publishing Bristol and Philadelphia.
3. Nanoparticles: Buildingblocks for Nanotechnology, Vincent Rotello-Springer.
4. Introduction to Nanotechnology: Charles P. Poole Jr., Frank J.Owens
5. Nanoparticles Edited by GunterSchmid.
6. Nanoscale Science and Technology: Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, John Wiley & Sons Ltd.
7. Nanoparticles &Nanostructure films: Preparation, Characterization & Applications: Wiley-VCH 8. Nanomaterials:AnIntroductiontoSynthesis,PropertiesandApplications:DieterVollath
9. NanostructuredMaterialsandNanotechnology:HariSinghNalwa,AcademicPress
10. Nanophotonics: Paras N Prasad, Wiley Interscience John Willey & Sons, Inc Publication
11. Handbook of Microscopy for Nanotechnology: Nan Yao, Zhong Lin Wang, Kluwer Academic Publishers.
12. Nanotechnology: Principles and Practice, S.K.Kulkarni, Capital Publishing Company.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C402.A.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Nanomaterials: Synthesis, Properties and Applications course to real life problems.	
C402A..2	2. Understanding of the Nanomaterials: Synthesis, Properties and Applications Physics course which will create scientific temperament..	
C402.A.3	Students will have hand on experience of Theory Based on : • Comparison of Nanomaterials with bulk material. • Different Techniques for synthesis of Nanomaterials of magnetic nanoparticles, Magnetic properties-Super paramagnetic materials. • Foundation for nanophotonics, Synthesis of metal chalcogenides (S, Se and Te) nanocomposites	

PHY-402(B):LASER and its Applications		
	Course description: This course is aimed at introducing the fundamentals of LASER and its Applications to the students. **Course objectives:** 1) To impart knowledge of basic concepts LASER and its Applications and Applications and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Basics of Lasers**: Introduction, Brief history of LASER, Interaction of radiation with matter, Einstein's prediction about emission, Absorption, Spontaneous and Stimulated emission, Einstein's coefficients and relations between them, Condition for light amplification, Population inversion, Pumping and pumping methods, Active medium, Pumping schemes. **(H-8, M-8)**	**08 L**
Unit 2	**Principles of Lasers**: Introduction, Optical resonator, Basic components of laser, Principle of laser action, Difficulties in laser process and their removal, Threshold condition for laser oscillation, resonance frequencies, Laser operating frequencies, Cavity configurations, Modes; Longitudinal and Transverse modes, Single mode operation. **(H-8, M-10)**	**08 L**
Unit 3	**Laser Rate equations:** Two level system. Three and four level system, Rate equations for three and four level system, Threshold pumping power, Relative merits and demerits of three and four level systems. **(H-6, M-8)**	**06 L**
Unit 4	**Laser Systems and Types**: Classification of Lasers: CW and Pulsed lasers, Detail discussion about constructional features, energy level diagrams, Laser action and working, characteristics etc of the following laser systems: I) Solid State Lasers: The Ruby Laser, Nd-YAG Laser, Nd-Glass Laser etc. II) Dye (Liquid) Lasers, III) Gas Lasers: • Atomic Gas Lasers: He-Ne Laser. • Ion Gas Lasers: Argon ion and Krypton ion lasers, He-Cd metal vapour laser, • Molecular gas Lasers: CO_2 Lasers, Eximer laser, N_2 laser etc. **IV)** Semiconductor lasers, V). Chemical Lasers: HF laser. CO_2 mixture lasers.**(H-14, M-18)**	**14 L**
Unit 5	**Laser beam characteristics**: Directionality, Intensity, Coherence, Monochromaticity, Polarization, Speckles', Measurements of Laser power, energy-wavelength, frequency, line width. etc. **(H-6, M-6)**	**06 L**
Unit 6	**Applications of Lasers**: Applications of lasers in Material Processing and Mechanical industries, Medicine and Surgery, Defense and Military applications, Laser Range finders. Optical communication, Holography, Electronic industries. Laser Spectroscopy. **(H-10, M-10)**	**10 L**

Suggested Readings: Reference Books:

1. Lasers – A.G.Sigman- Oxford University Press 1986.
2. Principles of Lasers- O.Suelto-Plenum, 1982.
3. An introduction to lasers and their applications. – D.C.O.Shea, W. Russell and W.T.Rhodes, Addison – Welslay Pub.Co. (1977)
4. Laser Systems and Applications- SatyaPrakash , PragatiPrkashan, IInd Ed, (2012)
5. An introduction to Lasers - Theory and Applications- M. N. Avadhanulu, S. Chand & C0. (2008)
6. Principles of laser and their Applications – by Callen, O'shea, Rhodes.
7. Lasers and non linear Optics – B.B. Laud (2nd edition).

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C402.B.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the LASER and its Applications course to real life problems.	
C402.B.2	2. Understanding of the LASER and its Applications of Physics course which will create scientific temperament.	
C402.B.3	Students will have hand on experience of Theory Based on : • Basics of Lasers: Introduction, Brief history of LASER, Interaction of radiation with matter, Einstein's prediction. • Laser Rate equations: Two level system. Three and four level system. • Laser beam characteristics: Directionality, Intensity, Coherence, Monochromaticity, Polarization, Speckles'. • Applications of lasers in Material Processing and Mechanical industries, Medicine and Surgery, Defence and Military applications.	

PHY-402(C): Astrophysics		
	Course description: This course is aimed at introducing the fundamentals of Astrophysics to the students. **Course objectives:** 1) To impart knowledge of basic concepts Astrophysics and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Astronomical Instruments:** Optical telescopes-refracting and reflecting- (Newtonian & Cassegrain), Radio telescopes, Hubble's space telescope, spectroscopes, photometry, spectro-photometry, Detectors & image processing. **(H-8, M-8)**	**08 L**
Unit 2	**Message from starlight:** Electromagnetic spectrum, Radiation from heated object, Doppler effect, Stellar spectra, determination of abundance of elements from stellar spectra. **(H-6, M-8)**	**06L**
Unit 3	**The Hertzsprung- Russel diagram:** Brightness and luminosity, population of stars, H-R diagram, variable and binary stars. **(H-4, M-6)**	**04 L**
Unit4	**Stellar Evolution:** Nuclear Fusion, Fusion reactions in stars formation of Helium, Carbon Oxygen and other reactions, E equation of state for stellar interior, Mechanical and thermal equilibrium in stars, stellar evolution, white dwarfs red giants, pulsars, neutron stars, black holes. **(H-10, M-12)**	**10 L**
Unit 5	**Galaxies:** Types of galaxies, evolution of galaxies, radio galaxies, seyfert galaxies, quasars, milky way galaxy. **(H-8,M-8)**	**08 L**
Unit 6	**General theory of relativity:** Space time & gravitation, vectors & tensors-contravariant & covariant vectors, symmetric and antisymmetric tensors, contraction, space time curvature, Geodesics, Principle of equivalence. **(H-9, M-10)**	**09L**
Unit 7	**Cosmology:** Big bang theory, steady state universe, oscillating universe, Hubble's law, experimental evidences for big bang, open and close universes. **(H-7, M-8)**	**07L**
Suggested Readings: Reference Books: 1. Astronomy-Fundamentals and Frontiers-Robert Jastow and Malcolm H. Thompson (Pub. John Wiley & Sons). 2. An Introduction to Astrophysics-Baidyanath Basu(Pub. Prentice Hall India Pvt. Ltd.).		

3. Introduction to Cosmology– J. V. Naralikar (Pub: Cambridge University Press).
4. An Introduction to the study of stellar structure-S. Chandarashekhar (Pub: Dover).
5. Measure of the universe-T.D. North (Pub. Oxford University Press).

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C402.C.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the LASER and its Applications course to real life problems.	
C402.C.2	2. Understanding of the LASER and its Applications of Physics course which will create scientific temperament..	
C402.C.3	Students will have hand on experience of theory based on : • Basics of Lasers: Introduction, Brief history of LASER, Interaction of radiation with matter, Einstein's prediction. • Laser Rate equations: Two level system. Three and four level system. • Laser beam characteristics: Directionality, Intensity, Coherence, Monochromaticity, Polarization, Speckles. • Applications of lasers in Material Processing and Mechanical industries, Medicine and Surgery, Defence and Military applications.	

M.Sc. Part II Semester IV (Physics): Elective Course (Select only one)

PHY-403(A): Renewable Energy Sources		
	Course description: This course is aimed at introducing the fundamentals of Renewable Energy Sources to the students. **Course objectives:** 1) To impart knowledge of basic concepts Renewable Energy Sources and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Solar Energy**: Solar Energy conversion systems and their applications, Fundamentals of photovoltaic. Energy conversion, Principles of photo voltaic cell, Materials and fabrication technologies of P. V cell, P.V. systems: configuration, output power and conversion efficiency, Basic P.V. system for power generation, Applications and limitations of P.V systems. **(H-9, M-10)**	**09 L**
Unit 2	**Biomass Energy Conversion Technologies**: Origin of biomass, Biomass energy resources, Biomass energy conversion processes, generation of gaseous fuels from biomass, digesters and their designs, Energy from Cereals, grains, sugar, fruits, starch etc. **(H-8 M-10)**	**08 L**
Unit 3	**Wind Energy**: Introduction to wind energy, Nature & Origin of winds, Power in a wind stream, principles and basic components of wind mill, Efficiency of wind turbine, horizontal and vertical axis wind mills, performance of wind mills, merits and limitations of wind energy conversions. **(H-9, M-10)**	**09 L**
Unit 4	**Ocean Energy**: Ocean as the potential energy resource: various ocean energy	**07 L**

	conversion technologies, Introduction to OTEC, Principle of OTEC, Open cycle OTEC system, closed cycle OTEC system, Ocean waves, energy and power from ocean waves, origin of tidal energy, Tidal energy conversion. **(H-7, M-8)**	
Unit 5	**Geothermal Energy**: Geothermal energy as are new able source of energy, Types of geothermal resources, Origin of geothermal resources, Hydro geothermal, Geopressure, geothermal and Petro geothermal resources, Basics of geothermal electric power plant. **(H-6, M-7)**	**06 L**
Unit 6	**Emerging trends in Renewable Energy sources:** Fuel Cells: Principle and operation of fuel cell, classification and types of fuel cells, Phosphoric acid fuel cell (PAFC), Alkaline fuel cell (AFC),Molten carbonate fuel cell (MCFC), Solid oxide fuel cell(SOFC), Fuels for fuel cells, Performance characteristics of fuel cells. Hydrogen Energy: Hydrogen as clean source of energy, sources Production, storage, Use of hydrogen as fuel, conversion to energy, Applications. **(H-13, M-15)**	**13 L**

Suggested Readings: Reference Books:

1. Energy Technology Non-Conventional, Renewable and Conventional, S. Rao, Dr.B.B. Parulekar, Khanna Publications, 3rdEd, 2005.
2. Non-Conventional Energy Sources, G. D. Rai, Khanna Publications, 2000.
3. Solar Energy Utilization, G.D. Rai, Khanna Publishers (1996).
4. Non-Conventional Energy Resources, Khan B.H., Tata McGraw Hill. 2006.
5. Solar Energy Conversion, S. P. Sukhatme (2ndedition).
6. Solar Cells, M.A. Green.
7. Hydrogen as Energy carrier Technologies systems Economy-Winter & Nitch.
8. Solar Energy Conversion– A. E. Dixnon & J. D. Leslie.
9. Biomass Energy– S.H. Pawar, L.J. Bhosale, A.B. Sabale, S.K. Goel.
10. Renewable Energy Sources and Conversion Technology, Bansal, N.K., M.KM. Meliss (1990)Tata McGraw Hill.
11. Non Conventional and Renewable energy sources, S.S. Thipse, Narosa Publishing House Pvt. Ltd.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C403.A.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of the Renewable Energy Sources course to real life problems.	
C403.A.2	2. Understanding of the Renewable Energy Sources of Physics course which will create scientific temperament..	
C403.A.3	Students will have hand on experience of Theory Based on: • Solar Energy: Solar Energy conversion systems and their applications. • Bio mass Energy Conversion Technologies: Origin of biomass, Biomass energy resources. • Ocean Energy: Ocean as the potential energy resource. • Emerging trends in Renewable Energy sources.	

PHY-403(B):Microwaves: Theory and Applications		
	Course description: This course is aimed at introducing the fundamentals of Microwaves: Theory and Applications to the students. **Course objectives:** 1) To impart knowledge of basic concepts Microwaves: Theory and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Transmission Lines:** Introduction to microwaves, applications of microwaves, Skin effect, Transmission line theory, Transmission line equations and their solutions, Open and terminated transmission lines, Line impedances, Line admittance, reflection coefficient, transmission coefficient, standing wave ratio, Impedance matching, Smith chart, Single stub matching and double stub matching. **(H-8, M-10)**	**08 L**
Unit 2	**Waveguides:** Rectangular and Circular waveguides, Solution of wave equation in rectangular coordinate, TE and TM modes in rectangular waveguide, Power transmission in rectangular waveguides, Power losses and excitation modes in rectangular waveguides. **(H-7, M-8)**	**07 L**
Unit 3	**Waveguide components:** Attenuators, filters, junctions, rectangular cavity resonator, circular cavity resonator, Enplane (series tee), H-plane (shunt tee), magic tee (Hybrid tee), directional couplers, hybrid rings (Rat-Race), waveguide corners, bends, loads, Microwave circular isolators. **(H-7, M-8)**	**07 L**
Unit 4	Microwave Generators: Microwave generation problems and principles, Tubes: Two cavity klystron and Reflex-klystron. Two cavity Klystron operation as amplifiers and oscillators, velocity modulation, bunching process, output power and beam loading efficiency of klystron. Reflex Klystron: Velocity modulation, power output efficiency, electronic admittance. Magnetron, Traveling wave tube amplifier: construction and operation. Microwave transistors: Principle of operation, microwave characteristics-cutoff frequency, current gain, power gain. Varactor diode: Principle of operation, use of varactor diode for frequency multiplication. Microwave Tunnel diode: Principle of operation, Gunn diode, PIN diode: Principle of operation, microwave characteristics. **(H-10, M-12)**	**10 L**
Unit 5	**Microwave Antennas:** Transmitting and receiving antenna: Horn antenna, Microwave dish antenna, antenna gain, resistance and band width, Beam width and polarization, Introduction to Micro strip antenna. **(H-6, M-6)**	**06 L**
Unit 6	**Measurements:** Smith chart: Derivation, use of chart for solving various problems in wave guide/ transmission lines, Microwave measurements: Measurement of impedance, power, frequency, attenuation, SWR, dielectric constant, quality factor. **(H-7, M-8)**	**07 L**
Unit 7	**Applications:** Radar: Block diagram and working of pulsed Radar system. Satellite: Active, passive, design requirements, payload, launching sequence. Microwave link, Microwave Remote Sensing Microwave ovens: Design requirements, sizes available, and application areas, Applications of microwaves in the medical field. **(H-7, M-8)**	**07L**

Suggested Readings: / Reference Books:

1. Microwave Devices and Circuits - Samuel Y. Liao, Prentice-Hall, New Delhi, 2006.
2. Microwave Engineering – Annapurna das & S.K. Das, Tata McGraw Hill, 2009.
3. Foundation of microwave engineering – Colin R.E. McGraw Hill 1969.
4. Introduction to microwaves – Atwater, McGraw Hill 1962-63.
5. Introduction to microwave – Wheeler, McGraw Hill 1962-63.
6. Microwave semiconductor devices and their circuit application.- Watson , McGraw-Hill 1962-63.
7. Microwave circuits and elements – M.L.Sisodia 8. Microwave circuits & passive Devices–M. L. Sisodia, G.S. Raghuvanshi, Wiley Eastern Ltd, 1987.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C403.B.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Microwaves: Theory and Applications course to real life problems.	
C403.B.2	2. Understanding of the Microwaves: Theory and Applications Physics course which will create scientific temperament..	
C403.B.3	Students will have hand on experience of Theory Based on : • Transmission Lines: Introduction to microwaves, applications of microwaves. • Waveguides: Rectangular and Circular waveguides. • Microwave generation problems and principles. • Microwave Antennas: Transmitting and receiving antenna. • Applications: Radar: Block diagram and working of pulsed Radar system. • Satellite: Active, passive, design requirements.	

PHY-403(C): Environmental Physics		
	Course description: This course is aimed at introducing the Environmental Physics: Theory and Applications to the students. **Course objectives:** 1) To impart knowledge of basic concepts Environmental Physics s: Theory and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. 3) The graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.	
Unit 1	**Introduction:** Meaning of Environment, Environmental science an overview, definition, concept & scope, types of environmental approaches, Nomenclature, environmental segments, Natural cycles (hydrologic, oxygen, nitrogen cycle). **(H-7, M-8)**	**07 L**
Unit 2	**Atmosphere:** Composition of atmosphere, Major regions of atmosphere, evolution of atmosphere, earth's radiation balance, Particles in the atmosphere, chemical & photochemical reactions in the atmosphere. **(H-8, M-8)**	**08 L**
Unit 3	**Environmental Resources:** Forest-Utilization, degradation & conservation, water-water cycle, degradation & conservation, Soil-utilization degradation & conservation. **(H-7, M-8)**	**07L**
Unit 4	**Pollution & environmental problems:** Meaning of pollution, sources, causes elementary fluid dynamics, factors governing air, water and noise pollution Green house effect/Global warming ozone hole. El Nino phenomenon. Acid Rain. **(H-6, M-8)**	**06 L**
Unit 5	**Water Pollution:** Aquatic environment, water pollutant, Sources of contamination of water pollution, waste water treatment, water quality parameters & standards, sampling, preservation, monitoring techniques pH dissolved oxygen, chemical oxygen demand, total oxygen demand, analysis of water quality parameter. **(H-9, M-10)**	**09 L**
Unit 6	**Air Pollution:** Air pollutant, air quality standard, sampling, monitoring, sampling, analysis technique, Gaseous and particulate matter. **(H-7, M-8)**	**07L**
Unit 7	**Global & Regional Climate:** Elements of weather and climate, stability and vertical and horizontal motion of air and water, viscous force, inertia force, Reynolds number, energy balance, pressure gradient force, global climate model and climate of India. **(H-8, M-10)**	**08L**
Suggested Readings: / Reference Books: 1. Environmental Chemistry: A.K. De		

2. Environmental Chemistry: O.D. Tyagi, M. Mehra (Anmol Publications).
3. Physics of atmosphere: J.T. Hougtion (Cambridge Uni.Press:1977)
4. Renewable Energy Sources: Elbs.1988.J.T.Widell & J. Weir.
5. Water Pollution (problems and Prospects): V.K. Prabhakar (Anmol Publications).
6. The Physics of Mansoons: R. N. Keshavmurthy & M. Shankar Rao Allied Publishers, 1992.
7. Solar Energy: S.P. Sukhatme.
8. Solid State Energy Conversion: S.H. Pawar, V.H.Shinde.
9. Environmental Physics: Egbert Boekar and Rienk Van Groundelle (John Willey).
10. An Introduction to Solar Energy for Scientists and Engineers: Sol-Wieder John Wiley, 1982.
11. Numerical Weather Prediction: G.J. Haltiner and R.T. Williams John Wiley, 1980.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C403.C.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Environmental Physics: Theory and Applications course to real life problems.	
C403.C.2	2. Understanding of the Environmental Physics: Theory and Applications Physics course which will create scientific temperament..	
C403.C.3	Students will have hand on experience of theory based on: • Meaning of Environment, Environmental science an overview, definition, concept & scope. • Composition of atmosphere, Major regions of atmosphere, evolution of atmosphere, earth's radiation balance. • Environmental Resources: Forest-Utilization, degradation & conservation, water-water cycle. • Water Pollution.. • Air Pollution.	

M.Sc. Part II Semester IV (Physics): Core Based Courses

PHY-404 Special Laboratory II	
	Course description: This course is aimed at introducing the Special Laboratory II: Practical and Applications to the students. **Course objectives:** 1) To impart knowledge of basic concepts Special Laboratory II: Practical and its Applications 2) The graduates will have knowledge of fundamental laws and principles in a variety of areas of Physics along with their applications. **3)** The **graduates will develop research skills which might include advanced laboratory techniques, numerical techniques, computer algebra, computer interfacing.**
	Perform at least **TEN** experiments from the following.

1	1. To find water of crystallization in Copper sulphate by TGA. 2. Differential thermal analysis [DTA] of $CuSO_4$, $5H_2O$. 3. Schottky barrier determination for various semiconductors. 4. To analyses the Raman Spectrum of a sample. 5. To determine Young's modulus of a metallic rod by Searle's optical interference method (Newton's Rings). 6. To analyses the photoluminescence spectrum of a given sample. 7. Determination of Curie temperature of a given sample. 8. Determination of calorific value of wood/cow dung. 9. Determination of wind power. 10. Wind data analysis of a given site. 11. Study of power vs. load characteristics of solar P.V. systems and study of series and parallel combination of solar P.V. panels. 12. Study of Optical Properties of Selective Coatings. 13. Hyperfine structure of spectral lines using FP etalon/L.G. plate. 14. To study the Quantum defects of S and P states of Na atom using constant deviation spectrometer. 15. Study of dielectric behavior of $BaTiO_3$ sample.
2	**Nanomaterials** 1. Synthesis of metal nanoparticles. 2. Synthesis of porous silicon. 3. Absorption by metal nanoparticles. 4. X-ray Diffraction of nanoparticles. 5. Photoluminescence of nanoparticles. 6. Synthesis of semiconductor nanoparticles by chemical method. 7. Optical absorption of nanoparticles (observation of Blue shift with size of particles). 8. Photoluminescence of nanoparticles (Luminescence decay time). 9. X-ray diffraction studies of nanoparticles (effect of temperature). 10. Density of states calculation of small clusters (experiments on computer).
3	**LASERS:** 1. To verify Heisenberg uncertainty principle using He-Ne laser source. 2. Study of Faraday's effect using Laser source. 3. Diameter of a given wire by diffraction. 4. Determination of bandwidth of a given optical fiber. 5. Measurement of reflectivity and transferability of thin film by using He-Ne laser. 6. Verification of Brewster's law of polarization using He-Ne laser. 7. Study of magneto-optic rotation and magneto-optic modulation. 8. To determine the wavelength of a LASER source using an engraved scale as a reflecting diffraction grating.
4	**Astrophysics :** 1. To estimate the temperature of an artificial tar by photometry. 2. To study characteristics of a CCD camera. 3. To study the solar limb darkening effect. 4. To polar assign an astronomical telescope. 5. To estimate there active magnitudes of a group of stars by a CCD camera.
5	**Microwaves :** 1. Study of passive components. 2. Study of various loads. 3. To study characteristics curve of Klystron. 4. Determination of constants of transmission line, strip lines. 5. Study of cavity resonator.

	6. Study of ring resonator and rejection filter. 7. To design, fabricate and test astripline resonator. 8. To find dielectric constant of given liquid using microwave bench. 9. Measurement of Quality factor Q of a microwave resonator.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C404.1	Course outcome: Learner will be able to …. 1. Apply the concept and use of knowledge of Special Laboratory II: Practical and Applications course to real life problems.	
C404.2	2. Understanding of Special Laboratory II: Practical Physics and Applications Physics course which will create scientific temperament.	
	Students will have hand on experience of theory based on : • Schottky barrier determination for various semiconductors. • To analyse the Raman Spectrum of a sample. • Nanoparticles. • LASERS. • Astrophysics. • Microwaves.	

M.Sc. Part II Semester IV (Physics): Skill Based Courses

PHY-405: M. Sc. Project – II (Project Dissertation)
Course Objectives: 1. To give exposure to the students to research culture and technology 2. To introduce students how to select a research topic, plan, perform experiments, collect data and analyse the data 3. To foster self-confidence and self-reliance in the students as he/she learns to work and think independently
Activities: 1. To complete the experimental work. 2. To carry out the measurements. 3. To characterize the samples. 4. To obtain the results. 5. To draw the conclusions. 6. To write the project report. 7. To appear for Internal examination 8. To appear for External examination **Project Report:** 1. Students have to write a 'project report'. 2. A report should be a concise account of project work containing full descriptions of the aims, method and outcomes. 3. Length of report should not normally exceed 40 pages. Assessment Criteria of the project: The

following criteria are to be used in assessing the project work:

(i)The conduct of project work:

The following questions are considered in assessing how well students have carried out the project work.:

1. How difficult was the project?
2. How well did the student understand the scientific principles behind the project?
3. How well did the student plan the project work?
4. How much effort was put into the project?
5. Was an interim report presented on time?
6. Is the student's project logbooks adequate?
7. How much initiative and/or originality did the student contribute to the project?
8. How well did the student cope with problems that arose during the course of project?
9. Did a project reach a stage of completion where meaningful results were obtained and definite conclusions could be drawn?

(ii) The Project Report:

1. How well did the report set out the background?
2. How well did the report describe the underlying them?
3. Was the report a reasonable length?
4. How well was the report structured?
5. How understandable was the written content?
6. How well did the report describe the execution of the project?
7. Did the report have an adequate summary or conclusions?

(iii) Oral Examination:

1. Did the student adequately describe what he/she had done in their project?
2. Did the student have a clear interpretation of his/her results?
3. What was the clarity and overall standard of the presentation?
4. How well was the talk/presentation structured?
5. Did the student cover all the relevant material in a reasonable time?

The project is allotted during the third semester. The students will get an opportunity to become a part of ongoing research activities in the respective supervisor's laboratory. The students will acquire skill to write, compile and analyze data if any, and present the detailed technical/scientific report. At the end of successful project semester training, potentially the students become employable in the industries/organizations.

It is expected that the students will design experiments and collect experimental data. At the end, they will submit a detailed thesis for evaluation. The students should be introduced to research methodology in the beginning through few lectures.

The systematic approach towards the execution of project should be as follows:

1. Selection of topic relevant to priority areas of Physics.
2. Collection of literature on the topic of research from libraries, internet, online journals, Planning of research experiments.
3. Performing the experiments with scientific and statistical acceptability.
4. Presentation of observations and results.
5. Interpretation of results and drawing important conclusions.
6. Discussion of obtained results with respect to literature reports.
7. Writing monthly progress report

8. Preparation of report (Dissertation) containing introduction, materials and methods, results and discussion, conclusions, bibliography and submission of at least 3 copies (1 copy retained in the department and after examination submitted to Library, 1 copy submitted to the guide and 1 copy kept with the candidate). 9. Presentation of research data during university examination and submission of project dissertation in abound form.
1. **Internal examination (40 marks):** Components of continuous internal assessment: Submission of progress report (8 marks), Literature collected, experiment planning and design (10 marks), Experiments conducted (10 marks), outcome of the experiments and viva (8 marks) and regular attendance (4 marks) recorded: Research Supervisors 2. **External examination, [PHY-305(60 Marks) + PHY-405 (60 marks)]** and Components of external assessment: Subject matter (5+5 marks), Review of literature (10+10 marks), Writing of dissertation submitted in bound form at the time of examination (Title page, Certificate, Main content: Abstract, Introduction, Literature, Materials and methods, results and discussion and conclusion with relevant references) (15+15 marks), Presentation structure (PPT format) (10+10 marks), Overall presentation reflecting contribution of work (5+5 marks), Response to questions (15+15 marks).
Suggested readings: Refer the topic in research papers, review articles published in peer reviewed and SCI indexed journals, reference books, abstracts, etc. related to topic of project dissertation

Course Outcomes (COts):
On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C405.1	Conceive a problem based on published research and carry out comprehensive survey of literature	**4**
C405.2	Plan and carry out task in given framework of dissertation and present the work in written and viva	**6**
C405.3	Use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.	**6**
C405.4	Learn handling of instruments, use of chemicals and how to conduct the experiments	**3**
C405.5	Learn how to present the project in power point and answer the queries to examiners as well as science of writing	**6**

M.Sc. Part II Semester IV (Physics): Audit Courses

	AC-401(A): Human Rights **(Professional and Social + Value Added Audit course; Practical; 2 Credits)** **(Optional:)**	
	Course Objectives (CObs): • To make students aware about human rights and human values.	
Unit 1	**Introduction to Human Rights** 1.1 Concept of Human Rights 1.2 Nature and Scope of Human Rights 1.3 Fundamental Rights and Fundamental Duties 1.4 Interrelation of Rights and Duties	**6 H**
Unit 2	**Human Rights in India** **2.1** Meaning and Significance of **:** 1) Right to Equality 2) Right to Freedom, 3) Right against Exploitation, 4) Right to Freedom of Religion, 5) Cultural and Educational Rights, and 6) Right to Constitutional Remedies.	**8 H**

	2.2 Constitutional Provisions for Human Rights 2.3 Declaration of Human Rights 2.4: National Human Rights Commission	
Unit 3	**Human Values** 3.1: Meaning and Definitions of Values 3.2: Importance of values in the life of Individual 3.3: Types of Values 3.4: Programmes for conservation of Values	**8 H**
Unit 4	**Status of Social and Economically Disadvantaged people and their rights** 4.1: Rights of women and children in the context of Social status 4.2: The Minorities and Human Rights 4.3: Status of SC/ST and other Indigenous People in the Indian Scenario 4.4: Human rights of economically disadvantaged Society	**8 H**

Suggested readings:

1. Human rights education – YCMOU, Nasik
2. Value education – SCERT, Pune
3. Human rights reference handbook – Lucille whare

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401A.1	Practice the learned issues under human rights and human values in real life.	**3**
AC401A.2	Provide social justices to people around them and provide guidance about human rights to their friends, parents and relatives.	**5**

AC-401(B): Current Affairs

(Professional and Social + Value Added Audit course; Practical; 2 Credits)
(Optional:)

Course Objectives (CObs):

- To make students updated about current affairs of India and world.

	Title	Content	Hours
Unit 1	Politics & Economy	• National & International Political Activity, Organization. • Economy & Business, Corporate world	**08**
Unit 2	Awards and recognitions	• National & International Awards and recognitions • Books and authors	**07**
Unit 3	Science & Technology	• Software, Automobile, Space Research • New inventions and discoveries	**07**
Unit 4	Environment & Sports	• Summit & conference, Ecology & Climate, Organization. • National & International Games, Olympics, commonwealth etc.	**08**

Suggested readings (Use recent years' data and current literature):

1. India 2019, by Publications Division Government of India.
2. Manorama Year Book by Philip Mathew.
3. India 2019, Rajiv Maharshi.
4. Quick General Knowledge 2018 with Current Affairs Update, Disha Experts.
5. General Knowledge 2018: Latest Who's Who & Current Affairs by RPH Editorial Board.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401B.1	Identify important issues currently/ recently happening in India or world.	**5**
AC401B.2	Summarize current affairs regularly.	**6**

AC-401(C): Seminar + Review Writing

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant biological information.

Writing a Scientific Literature Review:

- Choosing a topic, Deciding the scope of topic, Significance and impact of scientific problem being addressed, Relevance to subject, current issues and social relevance, Strengths and limitations of the study, Enticing broad audience.
- Literature Survey and Information to consider in the review:
  - Literature search using authentic library resources (print and non-print, digital and virtual) for Almanacs, Encyclopaedia, Dissertations, Theses, Research papers, Review articles, Reference/ Textbooks, and Popular articles (INFLIBNET, Google Scholar, PubMed, Highwire, Google patents, Indian patent database, etc.)
  - Analyzing the literature quality (indexing, peer review, citations, journal impact factor, etc.)
- Deciding a writing approach (theoretical, experimental, interpretive, clinical, etc.), prepare the highlights and drawing important conclusion from literature
- Sections to include and tips for writing them: Abstract, Introduction, Body, Discussion, Conclusion, References
- Reference styles (MLA, APA, etc.), Use of bibliography/ reference/ citation managers and generators (Reference Manager, End Note, Ref Works, Mendeley, Zotero, Qiqqa, etc.)
- Ethics of publication: Approval and consent, Data ethics (accuracy, falsification, fabrication, and confidentiality), Plagiarism and self-plagiarism, collaborative authorship, conflict of interest, legal consequences
- Content similarity detection, Use of anti-plagiarism services (Urkund, iThenticate, Turnitin, Copyscape, Grammarly, etc.)

Seminar Activity:

- Students are encouraged to deliver seminars on the topics of research, preferably published research paper in a reputed and indexed journal to develop presentation skills and enable to build confidence which will lead them to read different themes and enhance their scientific approach and knowledge assimilation abilities.
- Presentations must be created and presented by students using digital platform using a suitable software in the presence of student audience and faculty for evaluation

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401C.1	Retrieve, analyse, comprehend the scientific information on a given topic and derive logical inferences.	**4**
AC401C.2	Compile the scientific information on a topic, verify for similarity index or plagiarism.	**2**
AC401C.3	Deliver the interactive presentation of scientific data before audience and participate in open discussion with confidence.	**2**

	AC-401(D): Intellectual Property Rights (IPR) (Professional and Social + Value Added Audit course; Practical; 2 Credits) (Optional: Program-level)	
	Course Objectives (CObs): • To provide basic knowledge on intellectual property rights and their implications. • To understand ethical issues relevant to biology from the perspective of national and international law.	
Unit 1	**History and Introduction to Intellectual Property Rights:** Evolution of patent Laws, History of Indian Patent System, Concept of IPR, Designs, Trademarks TM, Trade Secret (TS), Domain Names, Geographical Indications, Copyright	**6 H**
Unit 2	**Classification of patents and ownership:** Classification of patents in India, Classification of patents by WIPO, Categories of Patent, Special Patents Ownership of patent, Rights of patent holder and co-owners, Duties of patent holder and co-owners, Transfer of patent Rights, Limitations of patent Rights, Restoration of Patents, Infringement of patent Rights and Offences, Actions against Infringement and Remedies and Relief	**6 H**
Unit 3	**Protection of biological materials and Biodiversity** Methods of protection of plant and plant products, Essentialities of plant protection, Plant variety protection and Farmers' Right Act, UPOV convention (plant Varieties) 1961, National Biodiversity Act- 2002, Protection of environment and biodiversity	**6 H.**
Unit 4	**Biosafety and good laboratory practices** Overview of biosafety, Risk assessment, Cartagena protocol on Biosafety, Biosafety Levels, GMOs and LMOs, Gene flow and environmental impact, opportunities and challenges Roles of Institutional Biosafety Committee, RCGM, GEAC in food and agriculture Risk analysis, assessment and management, International regulatory bodies Importance of good laboratory practices, General good laboratory practices	**6 H**
Unit 5	**Bioethics** Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies etc Bioethics in research – cloning and stem cell research in human, animal rights/welfare in experimentation Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations, biopiracy	**6 H**

Suggested readings:

1. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
2. Deepa Goel, Shomini Parashar (2013) IPR, Biosafety and Bioethics Always learning, Pearson Education India, ISBN 9332514240, 9789332514249.
3. Department of Biotechnology http://dbtindia.gov.in/guidelines-biosafety.
4. Ganguli, P. (2001). Intellectual property rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub.
5. International Union for the Protection of New Varieties of Plants. http://www.upov.int.
6. Kuhse, H. (2010). Bioethics: An anthology. Malden, MA: Blackwell.
7. National Biodiversity Authority. http://www.nbaindia.org.
8. National Portal of India. http://www.archive.india.gov.in.
9. Office of the Controller General of Patents, Design & Trademarks; Government of India. http://www.ipindia.nic.in/.
10. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem formulation in the environmental risk assessment for genetically modified plants. Transgenic Research, 19(3), 425-436. doi: 10.1007/s11248-009-9321-9.
11. World Intellectual Property Organisation. http://www.wipo.int.
12. World Trade Organisation. http://www.wto.org.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401D.1	Understand to classify, identify advantages of intellectual property and IPR	**3**
AC401D.2	Understand the need to protect biological diversity and follow bioethical practices in research work, awareness to protect intellectual property relevant to biology	**2**

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Equivalence Subject:

Old Course		New Course	
Course Number	**Title of the Course**	**Course Number**	**Title of the Course**
Sem. I		**Sem. I**	
PHY-101	Mathematical Methods for Physics	PHY-101	Mathematical Methods for Physics
PHY -102	Classical Mechanics	PHY -102	Classical Mechanics
PHY-103	Quantum Mechanics	PHY-103	Solid State Physics
PHY-104	Solid State Physics	PHY -104(A)	**A)**:Physics of Semiconductor Devices Or
		PHY -104(B)	**B)**: Electronic Instrumentation Or
		PHY -104(C)	**C)**Bio- Physics
PHY -105	Basic Physics Laboratory – I	PHY-105	Basic Physics Laboratory – I
Sem. II		**Sem .II**	
PHY-201	Statistical Mechanics	PHY-201	Statistical Mechanics
PHY -202	Classical Electrodynamics	PHY -202	Classical Electrodynamics
PHY -203	Material Science	PHY -203	Quantum Mechanics
PHY-204(A)	PHY 204 (A) : Physics of Semiconductor Devices	PHY-204	Material Science
PHY-204(B)	PHY 204 (B) : Electronic Instrumentation		
PHY-204(C)	PHY 204 (C) : Bio- Physics		
PHY-205	Basic Physics Laboratory – II	PHY-205	Basic Physics Laboratory – II
Sem. III		**Sem. III**	
PHY-301	Atomic and Molecular Physics	PHY-301	Atomic and Molecular Physics
PHY-302(A)	A)Materials Synthesis Methods	PHY-302(A)	A) Materials Synthesis and preliminary analysis
PHY-302(B)	B)Microprocessor and its Applications	PHY-302(B)	B) Computational Method sand Programming Using 'C' Language OR
PHY-302(C)	C)Communication Electronics	PHY-302(C)	C) Acoustics and Entertainment Physics
PHY-303	A)Systematic Materials Analysis	PHY-303(A)	A)Systematic Materials Analysis)OR
	B) Computational Methods and Programming Using 'C' Language	PHY-303(B)	B) Microprocessor and its Applications OR
	C) Acoustics and Entertainment Electronics	PHY-303(C)	C) Communication Electronics
PHY-304	Special Laboratory-I	PHY-304	Special Laboratory-I
PHY-305	Project Work-II (Literature Survey, Definition of Problem, Experimental work, Oral etc.)	PHY-305	Project Work-II (Literature Survey, Definition of Problem, Experimental work, Oral etc.)
Sem. IV		**Sem. IV**	
PHY-401	Nuclear Physics	PHY-401	Nuclear Physics
PHY -402(A)	A)Nanomaterials : Synthesis, Properties and Applications	PHY -402(A)	A)Nanomaterials: Synthesis, Properties and Applications OR

PHY -402(B)	B) LASER and it's Applications	PHY -402(B)	B) LASER and it's Applications OR
PHY -402(C)	C) Astrophysics	PHY -402(C)	C) Astrophysics
PHY-403(A)	A) Renewable Energy Sources	PHY-403(A)	A) Renewable Energy Sources OR
PHY-403(B)	B) Microwave: Applications	PHY-403(B)	B) Microwave: Applications OR
PHY-403(C)	C) Environmental Physics	PHY-403(C)	C) Environmental Physics
PHY -404	Special Laboratory-II	PHY -404	Special Laboratory-II
PHY -405	Project Work-II (Characterization, Analysis of Result, Conclusions, Project Report, Oral etc.)	PHY -405	Project Work-II (Characterization, Analysis of Result, Conclusions, Project Report, Oral etc.)