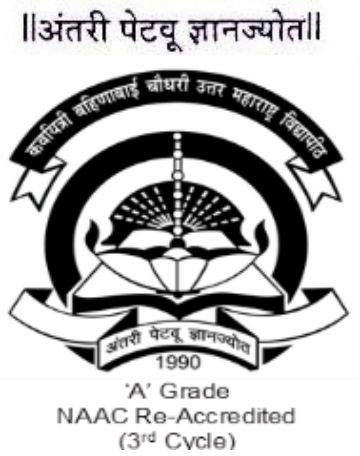
Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon



SYLLABUS

for

Master of Science (M. Sc.)

Physics

(with specialization in Materials Science and Energy Studies)

Choice Based Credit System

(Outcome Based Curriculum)

Department of Physics, School of Physical Sciences
Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon
425 001 (M.S.)

2019 - 2020

Summary of Distribution of Credits under CBCS Scheme
for
M.Sc. Physics (MS & ES)
at
School of Physical Sciences
[at University Campus under Academic Flexibility w.e.f. 2019-20]

Sr.No	Type of course	Sem I	Sem II	Sem III	Sem IV
01	Core (03 T + 01 P)	**16**	**16**	**16**	**16**
02	Skill based	**04**	**04**	**-**	**-**
04	School Elective/ Project	**-**	**-**	**04**	**04**
		-	**-**		
05	Audit	**02**	**02**	**02**	**02**
06	Total Credits	**22**	**22**	**22**	**22**

Subject Type	Core	Skill based	School Elective/ Project	Audit	practical	Total
Credits	48	08	08	08	16	88

(T, Theory; P, Practical)

Total Credits = 88

*** Materials Science: MS, Energy Studies: ES**

School of Physical Sciences
Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon
M. Sc. Physics (w. e. f. A. Y. 2019 -2020)

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 (Pract.)	Total Credits	
I	4	12 + 4	**16**	1	4 + 0	**4**	1	2	**2**	**22**
II	4	12 + 4	**16**	1	4 + 0	**4**	1	2	**2**	**22**
III	4	12 + 4	**16**	1	0 + 4	**4**	1	2	**2**	**22**
IV	4	12+ 4	**16**	1	0 + 4	**4**	1	2	**2**	**22**
Total Credits	**64**			**16**			**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	
(A)	**Prerequisite and Core Courses**									
	Theory	12	3	12	3	12	3	12	3	**48**
	Practical	4	1	4	1	4	1	4	1	**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) **Personality and Cultural Development**		**Semester III** (Choose One) **Technology + Value Added Course**		**Semester IV**(Choose One) **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-201 (A)	Soft Skills	AC-301(A)	Computer Skills	AC-401(A)	Human Rights
		AC-201 (B)	Sport Activities	AC-301(B)	Cyber Security	AC-401 (B)	Current Affairs
		AC-201 (C)	Yoga	AC-301(C)	Seminar + Review Writing	AC-401(C)	Seminar + Review Writing
		AC-201 (D)	Music	AC-301(D)	Biostatistics	AC-401(D)	Intellectual Property Rights (IPR)

Semester-wise Course Structure of M.Sc. I Physics (w.e.f. A Y 2019-2020)

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
						Internal		External		
			T	P	Total	T	P	T	P	
MS/ES-101	Core	Mathematical Methods For Physics	4	--	4	40	--	60	--	4
MS/ES-102	Core	Classical Mechanics	4	--	4	40	--	60	--	4
MS/ES-103	skill based	Electronics	4	--	4	40	--	60	--	4
MS/ES-104	Core	Quantum Mechanics – I	4	--	4	40	--	60	--	4
MS/ES-105	Practical	General Laboratory – I	--	4	4	--	40	--	60	4
AC-101	Audit Course	Practicing Cleanliness		2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 12; P = Practical: 4; Skill Based: 4; Audit Course:2)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
						Internal		External		
			T	P	Total	T	P	T	P	
MS/ES-201	Core	Quantum Mechanics – II	4	--	4	40	--	60	--	4
MS/ES-202	Skill Based	Experimental Techniques and Data Analysis	4	--	4	40	--	60	--	4
MS/ES-203	Core	Statistical Mechanics	4	--	4	40	--	60	--	4
MS/ES-204	Core	Electrodynamics	4	--	4	40	--	60	--	4
MS/ES-205	Practical	General Laboratory – II	--	4	4	--	40	--	60	4
AC-201/2/3/4	Audit Course	Choose one out of Four (AC-201/ AC-202/AC-203/AC-204) 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-wise Course Structure of M.Sc. II Physics (w.e.f. A Y 2020-2021)

Semester III

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
						Internal		External		
			T	P	Total	T	P	T	P	
MS/ES-301	Core	Atomic and Molecular Physics	4	--	4	40	--	60	--	4
MS/ES-302	Core	Solid State Physics	4	--	4	40	--	60	--	4
MS/ES-303	Core	MS: Elements of Materials Science ES: Renewable Energy	4	--	4	40	--	60	--	4
MS/ES-304	Core/ Practical	Special Laboratory - I	--	4	4	--	40	--	60	4
MS/ES-305	Elective	Project	--	4	4	--	40	--	60	4
AC-301/2/3/4	Audit Course	Choose one out of Four (AC-301/ AC-302/AC-303/AC-304) from Technology + Value Added Courses	--	2	2	--	100	--	--	2
Total Credit for Semester III: 22 (T = Theory: 12; P = Practical:4; Project/Elective:4; Audit Course:2)										

AC-301 Audit Course: C-Programming (Technology + value added course)

List of elective courses to be offered in Semester-III:

MS-305(A): Project in Materials Science MS-305(B): Project in Energy Studies

Semester IV

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
						Internal		External		
			T	P	Total	T	P	T	P	
MS/ES-401	Core	Nuclear Physics	4	--	4	40	--	60	--	4
MS/ES-402	Core	MS: Materials Synthesis Methods ES: Solar Photovoltaic Grid Connected Systems	4	--	4	40	--	60	--	4
MS/ES-403	Core	MS: Characterization of Materials ES: Energy Conversion and Management	4	--	4	40	--	60	--	4
MS/ES-404	Core/ Practical	Special Laboratory - II	--	4	4	--	40	--	60	4
MS/ES-405	Elective	Project	--	4	4	--	40	--	60	4
AC-401/2/3/4	Audit Course	Choose one out of Four (AC-401/ AC-402/AC-403/AC-404) from Professional and Social + Value Added Courses	--	2	2	--	100	--	--	2
Total Credit for Semester IV: 22 (T = Theory: 12; P = Practical:4; Project/Elective:4; Audit Course:2)										

AC-401 Audit Course: Review of Research Papers (Professional and Social + value added course)

List of elective courses to be offered in Semester-IV:

MS-405(A): Project in Materials Science MS-405(B): Project in Energy Studies

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 departmental exam/assessment)
Passing standards (separate head of passing)	:40% in each exam separately
Evaluation mode	: CGPA
Total Credits of the program	: 88 (64 core credits including 16 credit for practical's, 08 credits for skill based, 08 credits for Elective/Project, 08 credits for audit)

Program Objectives for M.Sc. Program:

1. To impart the profound theoretical and practical knowledge of the specific science discipline along with the fundamental core concepts
2. To train the students to employ modern techniques, tools, methodologies, equipment, hardware/software etc. to perform objective oriented scientific and planned experiments
3. To groom the students for all-round development and mould them in a trained workforce to provide teaching-learning, research, business, professional supports in the various science disciplines
4. To make the student to develop the ability to think analytically, independently and draw logical conclusions to solve real-life problems.
5. To utilize the skills and knowledge gained through the subject to deal with real life situations and problems related to society, environment, research and development etc.

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

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

PO No.	PO	Cognitive level
PO1	understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.	2
PO2	administer the skills in handling scientific instruments, planning and performing in laboratory experiments	3
PO3	analyse the given scientific experimental data critically and systematically and the ability to draw the objective conclusions.	4
PO4	develop various skills such as communication, managerial, leadership, entrepreneurship, teamwork, social, research etc., which will help in expressing ideas and views clearly and effectively	3
PO5	model and formulate the real problems and find solution based-on knowledge acquired	6
PO6	to evaluate how developments in any science subject helps in the development of other science subjects and vice-versa and how interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments.	5

Program Specific Objectives (PSOs):

- The said programme aims for the studies related to basic issues in Physics and Materials Science.
- The said programme also imparts training for synthesis of novel materials and their characterization for the various S &T applications.
- The students are also explored for the advances in the said area through training on advance equipments.
- The said programme aims for the studies related to basic issues in Physics and Energy Sciences.
- The said programme also imparts training in renewable energy issues.
- The students are also explored for the advances in the disciplines like Grid connected/ Off-Grid solar systems.

Program Specific Outcomes for M. Sc. Physics program

After completion of the M. Sc. Physics program, the students should be able to:

PO No.	**PSO**	**Cognitive Level**
PSO1	Apply gained knowledge and adapted skills to solve the real time problems in concern field.	**03**
PSO2	Focus on various future challenges associated to career in research laboratories/ Ph.D. Program/ Teaching/ International studies based on gained knowledge.	**04**
PSO3	Develop a thorough understanding of the fundamental principles, concepts, and processes of various academic fields of Physics and its subclasses.	**06**

Distribution of Course papers for M. Sc. Part I Physics

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part I (Physics with MS and ES)					
Semester I : Theory Courses					
MS/ES- 101	Mathematical Methods For Physics	Core course	04	100	03
MS/ES- 102	Classical Mechanics	Core course	04	100	03
MS/ES-103	Electronics	Core course	04	100	03
MS/ES- 104	Quantum Mechanics – I	Core course	04	100	03
Semester I : Practical Courses					
MS/ES-105	General Laboratory – I	Core course	**04+04**	**100**	**06**
AC-101	Practicing Cleanliness	**Audit course**	**02**	**100**	
Semester II : Theory Courses					
MS/ES-201	Quantum Mechanics – II	Core course	**04**	**100**	**03**
MS/ES- 202	Experimental Techniques and Data Analysis	Core course	**04**	**100**	**03**
MS/ES- 203	Statistical Mechanics	Core course	**04**	**100**	**03**
MS/ES- 204	Electrodynamics	Core course	**04**	**100**	**03**
Semester II : Practical Courses					
MS/ES-205	General Laboratory – II	Core course	**04+04**	**100**	**06**
AC-201A/B/C/D	Choose one out of Four (AC-201A/ AC-201B/ AC-201C/ AC-201D) from Personality and Cultural Development (Audit Course)	**Audit course**	**02**	**100**	

M.Sc. Part I Semester I Physics (Material Science and Energy studies): Core Courses

	MS/ES - 101: Mathematical Methods For Physics	
	Course Objectives: ➢ 1. This course has been developed to introduce students to some topics of Mathematical Methods for Physics which are directly relevant in different papers of M.Sc. Physics. ➢ 2. It includes functions of a Complex variable, Matrices, Special functions, Fourier series, Integral Transforms.	
Unit 1	**Vector spaces and Matrices** Definition of a linear vector space, Linear independence, basis and dimension, scalar Product, inner product, Orthonormal basis,Schwartz Inequality, Matrices, Orthogonal, Unitary, Eigen values and Eigen vectors of matrices, Matrix diagonalization,trace and normalization of matrix, Cayley-Hamilton theorem.	**10 L**
Unit 2	**Special Functions** Definition of special functions, Generating functions for Bessel function of integral order Jn(x), Legendre polynomials Pn(x), Generating functions for Pn(x), Hermite Polynomials, Generating functions for Hermit polynomials**.**	**08 L**
Unit 3	**Fourier series** periodic function, Euler Fourier formula, Dirichilete conditions, half range Fourier series, Change of interval, Parseval's identity, Application of Fourier series- Vibrating string, RLC circuit and Square Wave.	**10 L**
Unit 4	**Integral transforms** Integral transform, Laplace transform, Properties of Laplace transforms, Inverse Laplace Transform, Laplace transform of derivatives and integrals, Laplace's equation – application to electrostatic field Fourier Transforms: Fourier sine and cosine Transforms, odd and even functions, convolution theorem, Parseval's theorem	**14 L**
Unit 5	**Elements of complex analysis** Introduction, Analytic functions, Cauchy-Riemann conditions, Harmonic functions, Cauchy's integral formula, residue theorem, Residues at different poles, Contour Integrals, Taylor and Laurent series, singularities, Definite integrals.	**10 L**
Unit 6	Elementary Probability Theory A definition of the probability sample space, fundamental probability theorems, random variables, and probability distributions, special probability distribution, binomial, Poisson, normal	**08 L**

Suggested readings:

1. Mathematical Methods for Physicists: Tai L. Chow, 1st Edition, 2000, Cambridge University Press.
2. Mathematical Methods For Physics And Engineers: Riley, Hobson And Bence, 1st Edition, 1997, Cambridge University Presses.
3. Mathematical Methods in Physical Sciences: H. K. Das, S Chand Publications.
4. Matrices and Tensors in Physics: A.W. Joshi 3rd Edition, New Age International (P) Ltd.
5. Mathematical Methods for Physicists: G.B Arfken, H. J.Weber, 5th Edition, Harcourt Pvt. Ltd. (Academic Press).

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C101.1	Solve special functions and matrices for solving Quantum Mechanical Problems	**3**
C101.2	express matrices for solving linear algebraic equations and to use group theory for understanding of crystallography.	**6**
C101.3	Analyze Fourier series and integral transforms for analysis of wave mechanics and electrical circuit analysis.	**4**

	MS/ES - 102: Classical Mechanics	
	Course Objectives: ➢ 1. To develop familiarity with the physical concepts and the mathematical methods of classical mechanics. ➢ 2. To develop skills in formulating and solving physics problems.	
Unit 1	**Energy and Work** Conservative force, potential energy, conservative momentum and angular momentum, conservative system of particles of mass, motion of COM, conservation theorems & equation of motion under different types of forces.	**12 L**
Unit 2	**The Langrangian Formulation of Mechanics** Generalized coordinates, DoF, configurational space, constraints, D'Alembert's principle and Lagrange's equations, kinetic energy in generalized coordinates, generalized momentum and energy, Gauge invariance, cyclic or ignorable coordinates.	**12 L**
Unit 3	**Hamiltonian Dynamics** Hamilton's principle and Lagrange's equations, Lagrange's equation for non-holonomic systems, few examples of Lagrange's equation of motion, method of undetermined multipliers, the Hamiltonian of the dynamical system, Hamilton's canonical equations, canonical transformations, Poisson's bracket, phase space, Lagrange from Hamiltonian, few application of Hamiltonian formulation.	**12L**
Unit 4	**Central Force Motion** The two body problem and the reduced mass, general properties of central force motion, effective potential and classification of orbits, general solutions, inverse square law of the force, Kepler's law of planetary motion.	**12L**
Unit 5	**Coupled Oscillations** Coupled pendulum, normal coordinates, coupled oscillators and normal oscillators, and normal modes, equation of motion of a coupled system, normal modes of oscillation, orthogonality of Eigenvectors, normal coordinates.	**12 L**

Suggested readings:

1. Classical Mechanics: T.L.Chow 1st Edition, 1995, John Willey and Sons Inc.
2. Classical Mechanics: Takwale, Puranic 1st Edition, 2007, Tata McGraw Hill Publication
3. Classical Mechanics: H.Goldstein 2nd, Edition, 1980, Narosa Publishing House
4. Classical Mechanics: Rana and Joag, 1st Edition, Tata McGraw Hill Company Ltd.
5. Classical Mechanics: A Modern Perspective- Barger and Olsson 2nd Edition, 1995, McGraw Hill Publication.

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

CO No.	CO	Cognitive level
C102.1	Interpret the physical principles behind the derivation of Lagrange and Hamilton's equations, and the advantages of these formulations,	**2**
C102.2	Evaluate different problem-solving strategies within mechanical physics and assess which of these strategies is most useful for a given problem,	**4**
C102.3	Estimate the fundamental principles of central force motion	**5**
C102.4	Explain the intricacies of coupled oscillations.	**3**

M.Sc. Part I Semester I Physics: Skill Based Course

	MS/ES - 103: Electronics (Skill base)	
	Course Objectives: ➢ 1. To understand structure and characteristics of analog and digital electronic devices. ➢ 2. To understand the working of these devices in different applications.	
Unit 1	**Semiconductor devices** Diodes, transistors, Field Effect Devices, homo and hetero-junction devices: device structure, device characteristics, frequency dependence and applications. Opto-electronic devices: solar cells, photo-detectors, LEDs	**12 L**
Unit 2	**Bi-Junction Transistor Amplifiers** Transistor DC biasing circuits: DC load line, Q-point, base bias, voltage divider bias, Emitter bias, collector feedback bias, Emitter feedback bias: circuit analysis Amplifier AC equivalent circuits: ac analysis of transistors, small signal analysis, H parameters	**14 L**
Unit 3	**Amplifiers and Oscillators** Feedback: Positive and negative feedback and their effects, Oscillators: Introduction, Barkhausen criteria, Wien bridge, phase shift, Colpitt and Hartley. Amplifier properties: gain, input and output impedance, Class A, B and C amplifiers, power amplifiers	**12 L**
Unit 4	**OPAMP circuits** Linear Op Amp Circuits, Non Linear Op Amp Circuits, applications: integrator, differentiator, comparator, Schmidt trigger, active filters	**10 L**
Unit 5	**Digital Electronics** Digital Electronics-Logic gates, Arithmetic circuits, Flip Flops, NAND & NOR gates as building blocks, X-OR Gate, simple combinational circuits, K-Map, Flip-flop, shift register, counters, Basic principles of A/D & D/A converters ; Simple applications of A/D & D/A converters.	**12 L**

Suggested readings:

1. Semiconductor Physics and Devices- Donald A. Neaman3rd Edition, 2007, Tata McGraw Hill Company.
2. Electronic Principles- A. Malvino, D.J. Bates7th Edition, 2008, Tata McGraw-Hill Publication Pvt Ltd.
3. Introductory Electronic Devices And Circuits- Painter2nd Edition, 1991, New Jerky; Regents/Prentice Hall
4. Electronic Devices And Circuits-Michael Hassul, Don Zimmerman Prentice Hall
5. Operational Amplifiers – G.B.Clayton (5th edition) Newnes

6. Operational Amplifiers Applications – G.B.Clayton
7. Digital Principles and Applications : Malvino and Leach

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C103.1	Interpret structure and theory behind working of few important analog and digital electronics devices.	**2**
C103.2	Analyze the circuits based on these devices.	**4**
C103.3	Memorize how these devices are utilized in different applications.	**1**

	MS/ES - 104: Quantum Mechanics - I	
	Course Objectives: ➢ 1. To gain knowledge about the time-dependent and time-independent Schrödinger equation for simple potentials like for instance the harmonic oscillator and hydrogen like atoms. ➢ 2. To apply principles of quantum mechanics to calculate observables on known wave functions.	
Unit 1	**The Origin of Quantum Theory** Inadequacy of classical Physics, de Broglie hypothesis, wave-particle duality, Born's interpretation of wave function, wave function for particle momentum, wave packets, the Heisenberg's uncertainty principle.	**12 L**
Unit 2	**Schrodinger Equation** Necessity of wave equation and the conditions imposed on it, time dependent Schrodinger equation, Conservation of probability, Expectation values, Ehrenfest theorem, time independent Schrodinger equation, Eigen functions and Eigen values, Stationary states, orthogonality of eigen functions, parity, continuity and boundary conditions.	**10 L**
Unit 3	**One Dimensional Energy Eigen value problems** Free particle, infinite square well, potential step, square potential barrier, explanation of alpha decay, square well potential, Linear harmonic oscillator.	**12 L**
Unit 4	**Formalism of Quantum Mechanics** Postulates of quantum mechanics, representation of states and dynamical variables, observables, self-adjoint operators, eigen functions and eigen values, degeneracy, orthogonality, orthonormality, completeness and closure property, physical interpretation of eigen values, eigen functions and expansion coefficients, eigen values and eigen functions of momentum operator, Dirac's bra and ket notations, linear operators, unit operator, hermitian operator, unity operator, parity operator, eigen values and eigen functions of simple harmonic oscillators by operator method.	**14 L**
Unit 5	**Angular Momentum** Orbital angular momentum, angular momentum algebra, angular momentum as a generator of infinitesimal rotations, Eigen values and functions of L2 and Lz, ladder operators L- and L+, spin angular momentum, Pauli's spin matrices, addition of angular momenta, representation of J in ljm> basis, computation of Clebsch-Gordan coefficients in simple cases (J1=1/2, J2=1/2).	**12 L**
Suggested readings: 1. Quantum Mechanics: B. H. Bransden and C. J. Joachain, 2nd Edition, 2004, Pearson Education ltd. 2. Quantum Mechanics: L. I. Schiff, 3rd edition, 1998, MGH book company.		

3. Quantum Mechanics: J. D. Powell and B. Crossman. 1st edition, 1998, Narosa Publishing House.
4. Quantum Mechanics: S. Gasiorowicz, 3rd edition, 2003, Wiley International.

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

CO No.	CO	Cognitive level
C104.1	Explain the differences between classical and quantum mechanics	**2**
C104.2	express the idea of wave function	**2**
C104.3	formulate the uncertainty relations	**6**
C104.4	Solve Schrödinger equation for simple potentials	**3**

MS/ES-105: General Laboratory - I

	MS/ES – 105 General Laboratory - I	
	Course Objectives: ➢ Acquire the appropriate data accurately and keep systematic record of laboratory activities. ➢ Interpret findings using the correct physical scientific framework and tools. ➢ Prepare professional quality textual and graphical presentations of laboratory data and computational results. ➢ Evaluate possible causes of discrepancy in practical experimental observations, results in comparison to theory.	
	Common Experiments 1. Acquire the appropriate data accurately and keep systematic record of laboratory activities. 2. Interpret findings using the correct physical scientific framework and tools. 3. Prepare professional quality textual and graphical presentations of laboratory data and computational results. 4. Evaluate possible causes of discrepancy in practical experimental observations, results in comparison to theory. 5. To calculate A_v, A_I, R_o& R_i of CE RC-Coupled amplifier with potential divider biasing. 6. Study of Electronic Filters 7. Study of Active Low Pass Filter 8. Study of Active High Pass Filter 9. Measurement of ideality factor, reverse saturation current and diode capacitance. 10. Determination of skin-depth in metals. 11. Determination of Energy band gap using diode heating. 12. To find out the root of differential equation by Newton Rapson Method. 13. To find out the root of differential equation by Bisection Method. 14. To find out the root of differential equation by Regula-falsi Method. 15. To find the solution of integration of given function by Trapezoidal Method. 16. To find the solution of integration of given function by Simpson's 1/3 method. (*Only ten practical's has to be performed by MS and ES students.)	
Suggested readings: 1. Semiconductor Physics and Devices- Donald A. Neaman3rd Edition, 2007, Tata McGraw Hill		

Company.
2. Electronic Principles- A. Malvino, D.J. Bates7th Edition, 2008, Tata McGraw-Hill Publication Pvt Ltd.
3. Introductory Electronic Devices And Circuits- Painter2nd Edition, 1991, New Jerky; Regents/Prentice Hall
4. Electronic Devices And Circuits-Michael Hassul, Don Zimmerman Prentice Hall
5. Operational Amplifiers – G.B.Clayton (5th edition) Newnes
6. Operational Amplifiers Applications – G.B.Clayton
7. Digital Principles and Applications : Malvino and Leach.
8. Introductory Methods Of Numerical Analysis S.S.Sastri 2nd Edition, 1992, Prentice Hall Of India Pvt. Ltd.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C105.1	Express various experimental and computational tools thereby developing analytical abilities to address real world problems.	**2**
C105.2	Adapt the skills related to research, education, and industry academia.	**6**
C105.3	Solve the various issues concerned to the laboratory work.	**3**

M.Sc. Part I Semester I Physics: Audit Courses

AC-101: Practicing Cleanliness

(Compulsory; Campus-level Audit Course; Practical; 2 Credits)

Course Objectives (CObs):

- To make students aware of Clean India Mission and inculcate cleanliness practices among them.

- Awareness program on
  - Swachh Bharat Abhiyan (Clean India Mission)
  - Clean Campus Mission
  - Role of youth in Clean India Mission
- Cleaning activities inside and surroundings of Department buildings.
- Tree plantation and further care of planted trees
- Waste (Liquid/Solid/e-waste) Management, Japanese 5-S practices
- Planning and execution of collection of Garbage from different sections of University campus
- Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance.
- Cleanest School/Department and Cleanest Hostel contests
- Painting and Essay writing competitions

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

CO No.	CO	Cognitive level
AC101.1	Identify need at of cleanliness at home/office and other public places.	**2**
AC101.2	Plan and observe cleanliness programs at home and other places.	**4**
AC101.3	Practice Japanese 5-S practices in regular life.	**3**

M.Sc. Part I Semester II Physics: Core Courses

	MS/ES - 201: Quantum Mechanics - II	
	Course Objectives: ➢ 1. This course is designed for students to gain knowledge about the approximate methods for solving the Schrödinger equation. 2. To solve the problems associated with the variational method, perturbation theory, WKB method.	
Unit 1	**Central Potential** Separation of the Schrodinger equation in spherical polar co-ordinates, the hydrogen atom, energy levels, the Eigenfunction of the bound states.	**12 L**
Unit 2	**Time independent Perturbation theory** Time independent perturbation theory: Non-degenerate and degenerate cases (upto 2^{nd}order). Applications: anharmonic oscillator, Zeeman effect, Stark effect.	**12 L**
Unit 3	**Time dependent Perturbation theory** Time dependent perturbation theory: First order perturbation, harmonic perturbation, transition to continuum states, absorption and emission of radiation, Einstein's coefficients, Fermi's golden rule.	**14 L**
Unit 4	**Variational Method** Variational method: Basic principles and applications to particle in box, simple harmonic oscillator, hydrogen atom.	**10 L**
Unit 5	**WKB Approximation** WKB approximation: Qualitative development and condition for validity of this approximation, Bohr's quantization condition, applications to tunnelling such as α-particle field emission.	**12 L**
Suggested readings: 1. Quantum Mechanics: B. H. Bransden and C. J. Joachain, 2nd Edition, 2004, Pearson Education ltd. 2. Quantum Mechanics: L. I. Schiff, 3rd edition, 1998, MGH book company. 3. Quantum Mechanics: J. D. Powell and B. Crossman. 1st edition, 1998, Narosa Pub. House. 4. Quantum Mechanics: S. Gasiorowicz, 3rd edition, 2003, Wiley International.		

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

CO No.	CO	Cognitive level
C201.1	Apply the variational method for various numerical	**3**
C201.2	Anticipate principles of time-independent perturbation theory, time-dependent perturbation theory express the idea of wave function	**6**
C201.3	Evaluate problems associated to WKB method	**5**

M.Sc. Part I Semester II Physics: Skill Based Course

	MS/ES - 202: Experimental Techniques and Data Analysis	
	Course Objectives: ➢ 1. Objective of this course is to learn experimental techniques and data analysis during any type of experiment. ➢ 2. To learn related theory and study the practices necessary for solving the problems in data analysis.	
Unit 1	**Measurement, Interpretation and analysis** Basic definitions, Accuracy and precision, significant figures, types of errors: gross errors, systematic errors, random errors, statistical analysis: arithmetic mean, deviation from the mean, average deviation, standard deviation, probability of errors: Normal distribution of errors, probable errors, propagation of errors	**10 L**
Unit 2	**Curve fitting, Cubic Splines and Approximations** Introduction, least square fitting procedures: Fitting a straight line, Non-linear curve fitting, Curve fitting by a sum of exponentials; Data fitting with cubic splines: derivation of the governing equations, end conditions, minimizing property of cubic splines; Approximation of functions: Chebyshev polynomials, Economizing of power series, chi-square test	**15 L**
Unit 3	**Transducers** Classification of transducers, selecting a transducer. Working principle and characteristics of the main transducers for measurement of: Temperature, pressure, Production and measurement of low pressure (vacuum)	**15 L**
Unit 4	**Signal Conditioning: Processes** Input/output impedance, Impedance matching, Amplification: the Differential amplifier, Instrumentation amplifiers, Modulation techniques: Amplitude modulation, Frequency modulation, phase modulation	**10 L**
Unit 5	**Signal Conditioning: Recovery and Conversion** Demodulation, Filters, Noise reduction, Lock-in-amplifiers, phase locked loop, Box car integrators, Fourier transforms, sample and hold unit, ADC: quantization, resolution, sampling frequency	**10 L**

Suggested readings:

1. Modern Electronic And Measurement Techniques-A.D.Helfrick,W.D.Kooper 1st Edition,2004, Prentice Hall Of India Pvt. Ltd.
2. Instrumentation: Devices And Systems- Rangan, Mani, Sharma, 1st Edition,1990, Tata McGraw Hill Publication Pvt. Ltd.
3. Introductory Methods Of Numerical Analysis S.S.Sastri 2nd Edition, 1992, Prentice Hall Of India Pvt. Ltd.
4. Introduction To Instrumentation And Control- A.K.Ghosh, 1st Edition, 2000, Prentice Hall Of India Pvt. Ltd.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C202.1	Describe the error free measurements, interpretation and data analysis	**3**
C202.2	Explain the conversion of physical quantity into electrical forms and physics behind its conversion	**2**
C202.3	Judge the signal conditioning and its recovery processes	**3**

	MS/ES - 203: STATISTICAL MECHANICS	
	Course Objectives: ➢ 1. The objective of the course is to enable students to get familiar and experience with various aspects and novelty of statistical mechanics. ➢ 2. To develop the understanding of basic statistical phenomenon.	
Unit 1	**Laws of Thermodynamics** Necessity of Statistical Mechanics The laws of thermodynamics and their consequences, phasespace,Statistical description of system of particles: state of a system, microstates, ensembles,basic postulates	**12 L**
Unit 2	**Statistical Description of System of Particles and Statistical Thermodynamics** Behaviour of density of states, density of states for ideal gas in classical limit, thermal and mechanical interactions, quasi-static process Statistical thermodynamics: Irreversibility and attainment of equilibrium, Reversible and irreversible processes, thermal interaction betweenmacroscopic systems, approach to thermal equilibrium, dependence of DoS on external parameters, Statistical calculation of thermodynamic variables.	**12 L**
Unit 3	**Classical Statistical Mechanics** Microcanonical ensemble and their equivalence, canonical and grand canonical ensembles, partition function, thermodynamic variables in terms of partition and grand partition functions, ideal gas, Gibbs paradox, validity of classical approximation, equipartition theorem, MB gas velocity and speed distribution, Chemical potential, Free energy and connection withthermodynamic variables	**12L**
Unit 4	**Formulation of Quantum Statistics** Formulation of quantum statistics, ensembles in quantum statistical mechanics, The theory of simple gases: Maxwell Boltzmann, Bose-Einstein, Fermi-Dirac gases, Statistics of occupation numbers, Evaluation of partition functions, Ideal gases in the classical limit	**12L**
Unit 5	**Ideal Bose and Fermi Systems** Ideal Bose system: Thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation Thermodynamics of Black-bodyradiation, Stefan-Boltzmann law, Wien's displacement law, Specific heat of solids (Einstein and Debye models) Ideal Fermi systems: Thermodynamic behavior of an ideal Fermi gas, degenerate Fermi gas, Fermi Energy and mean energy, Fermi Temperature, Fermi velocity of a particle of a degenerate gas	**12 L**

Suggested readings:

1. Fundamentals Of Statistical And Thermal Physics-F.Reif 1st Edition, 1965, McGraw Hill Publication Pvt. Ltd
2. Statistical Mechanics- K. Huang 1st Edition, 1991, Wiley Eastern Ltd.
3. Statistical Mechanics-R.K. Patharia 2nd Edition, Elsevier

4. Statistical Physics – F.Reif. Berkeley Physics Course (Vol.5), Tata McGraw Hill Pvt. Ltd.
5. Fundamentals Of Statistical Mecanics-B.B.Laud Edition, 2007,New Age International Publishers.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C203.1	Describe various aspects of statistical mechanics	**1**
C203.2	Interpret thermodynamics of various systems	**3**
C203.3	Distinguish different laws of thermodynamics	**2**

	MS/ES - 204: Electrodynamics	
	Course Objectives: ➢ 1. To understand the basics of electrostatics, magneto statics, electrodynamics and the potential formulation of basic laws. ➢ 2. To understand how to apply basic theories in electromagnetic waves and radiation.	
Unit 1	**Electrostatics and Magnetostatics** The electric field, continuous charge distribution, divergence and curl of electrostatic fields, Gauss's law and applications, electric potentials, Poison's equations and Laplace equation, the potential of localized charge distribution, electrostatic boundary condition, work and energy in electrostatics. Biot-Savart's laws, divergence and curls of B, Amperes law and its applications, magnetic vectors potential: the vector potential, magnetostatic boundary conditions, multipole expansion of the vector potential.	**10 L**
Unit 2	**Special Techniques** Laplace equation in one, two and three dimensions, boundary conditions and uniqueness theorems, The method of images, the classic image problem, other image problems, spherical co-ordinates, multipole expansion, approximate potentials at large distances, the monopole and dipole terms, origin of coordinates in multipole expansions	**10 L**
Unit 3	**Electrodynamics** Electromotive force, electromagnetic induction: Faraday's law, The induced electric field, Inductance,energy in magnetic fields, Maxwell's equation's: Electrodynamics before Maxwell, How Maxwell fixed Amperes law?, Maxwell's equations, magnetic charge, Maxwell's equations in matter, boundary conditions, conservation laws, the continuity equation and Pointing's theorem	**10 L**
Unit 4	**Electromagnetic waves** Boundary conditions, reflection and transmission, polarization, electromagnetic waves in vacuum, wave equations for E and B, monochromatic plane waves, energy and momentum in electromagnetic waves, electromagnetic waves in matter, propagation in linear media, R and T at normal incidence, absorption and dispersion, electromagnetic waves in conductors, reflection at conducting surface, guided waves, wave guides, TE waves in rectangular waveguides, the co-axial transmission line.	**12 L**
Unit 5	**Potential Fields**	**10 L**

	The potential formulation, scalar and vector potentials, gauge transformations, Coulomb and Lorentz's gauge, Continuous distributions: retarded potentials, Jefimenko's equations, Point charges: Lienard-Wiechert potential, field of moving point charge.	
Unit 6	**RADIATION** Dipole radiation, electric dipole radiation and magnetic dipole radiations: E and B radiated, Energy flux and power radiated, Radiation from an arbitrary source, power radiated by a point charge	**08 L**

Suggested readings:

1. Introduction to Electrodynamics- D.J. Griffith3rd Edition, 2000, Prentice Hall Of India.
2. Electromagnetic Field Theory Fundamentals- Guru AndHiziroglu2ndEdition , 1998, Cambridge University Press.
3. Introduction To Electromagnetic Fields-Paul And Nasar.2nd Edition, 1987, McGraw Hill Company Pvt. Ltd.
4. Classical Electrodynamics- J.D.Jackson3rd Edition,2007,Wiley India Pvt Ltd
5. Electricity And Magnetism- Edward Purcell(For Basic Readings)2nd Edition, Tata McGraw Hill Publication Pvt. Ltd
6. Fundamentals Of Applied Electromagnetics- FawwazUlaby1st Edition, 2002, Prentice Hall Of India Pvt. Ltd.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C204.1	Interpret the basic theories governing the electricity and magnetism	**2**
C204.2	Apply the basic theories in electromagnetic waves and radiation	**3**
C204.3	Recognized to apply the basic theories to real problems	**1**

	MS/ES - 205: General Laboratory - II	
	Course Objectives: ➢ 1. To gain practical knowledge by applying the experimental methods to correlate with the physics theory. ➢ 2. To learn the usage of electrical and electronic systems for various measurements. ➢ Apply the analytical techniques and graphical analysis to the experimental data. ➢ To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.	
	1. To determine the characteristic of G-M tube. 2. Determination of Planck's constant using LED. 3. To plot the frequency response of RC-Coupled Amplifier. 4. Measurement of Temperature dependent resistivity using Four Probe Method. 5. To study the out wave form by suing Oscillator/Multivibrators. 6. Straight Linear Fitting using C programming.	

	7. Non-liner (Power and exponential) fitting using C programming. 8. Calculation of Standard deviation by C programming using given data. 9. Solution of differential equation using first Order Euler's Method. 10. Solution of differential equation using Ffurth order Runge Kutta method (*Only ten practical's has to be performed by MS and ES students.)	

Suggested readings:

1. Introductory Electronic Devices And Circuits- Painter2nd Edition, 1991, New Jerky; Regents/Prentice Hall
2. Electronic Devices And Circuits-Michael Hassul, Don Zimmerman Prentice Hall
3. Operational Amplifiers – G.B.Clayton (5th edition) Newnes
4. Operational Amplifiers Applications – G.B.Clayton
5. Digital Principles and Applications : Malvino and Leach.
6. Introductory Methods Of Numerical Analysis S.S.Sastri 2nd Edition, 1992, Prentice Hall Of India Pvt. Ltd.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C205.1	Interpret the behavior of electronic components and perform analysis and design of bias circuits for diodes, transistors etc	**2**
C205.2	Set up testing strategies and select proper instruments to evaluate performance characteristics of electronic circuit.	**4**
C205.3	Choosing testing and experimental procedures on different types of electronic circuit and analyze their operation different operating conditions.	**4**

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

	AC-201(A): Soft Skills **(Personality and Cultural Development Related Audit course; Practical; 2 Credits)** **(Optional: Campus-level)**	
	Course Objectives (CObs): ➢ To inculcate different soft skills among students.	
Unit 1	**Introduction to soft skills** Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal setting, life skills, Need for soft skills, Communication skills, Etiquettes& Mannerism.	**2 hrs.**
Unit 2	**Self-Assessment** Goal setting, SWOT analysis, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements, positive attitude, positive thinking and self-esteem. Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.	**4 hrs.**
Unit 3	**Communication Skills** Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait, dressing sense, facial expressions, peculiarity of speaker (habits). Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real-life story for 5 minutes each), Oral review (Each student	**8 hrs.**

	orally presents a review on a story or a book read by them) Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.	
Unit 4	**Formal Group Discussion, Personal Interview & Presentation skills** Topic comprehension, Content organization, Group speaking etiquettes, driving the discussion & skills. Preparation for personal interview: dress code, greeting the panel, crisp self-introduction, neatness, etiquettes, language tone, handling embarrassing & tricky questions, graceful closing. Activity: Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback. Mock interview are to be conducted.	**4 hrs.**
Unit 5	**Aptitude and analytical skills** Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking. Analytical skills: Definition, Types, problem solving	**8 hrs.**
Unit 6	**Life skills** Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.	**4 hrs.**

Suggested readings:

1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd.
2. English for Business Communication: Simon Sweeney, Cambridge University Press
3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press
4. Quantitative Aptitude: R.S. Agrawal

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
AC201A.1	Identify their lacunas about some soft skills and try to overcome the same.	**2**
AC201A.2	Practice learned soft skills in real life and do their jobs more effectively.	**3**

	AC-201(B): Practicing Sports Activities **(Personality and Cultural Development Related Audit course; Practical; 2 Credits)** **(Optional: Campus-level)**	
	Course Objectives (CObs): • To motivate students towards sports and provide them required training.	

SR	NAME OF THE	SYLLABUS OF THE	TIMING	SEMESTER

NO.	SPORT/GAME (Select ONE of the Following)	COURSE	(02 Hours in a Week)	
1	Volleyball	• General Fitness • Basic Fitness • Specific Fitness • History of the Game • Basic Skill of the Game • Major Skill of the Game • Technique & Tactics of the Game • Game Practice	Morning : 07 to 09 AM OR Evening : 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
AC201B.1	Identify one or more sports of their choice and develop more interest to participate at University/National level sport events.	**2**
AC201B.2	Practice the learned sports activities regularly in real life.	**3**

AC-201(C): Practicing Yoga

(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives:

- To motivate students towards yoga and provide them required training.

- Yog: Meaning, Definition & Introduction, Objectives
- Primary Introduction of Ashtanga Yoga
- Preparation of Yogabhyas
- Omkar Sadhana, Prayer, Guru Vandana
- Sukshma Vyayamas
- Suryanamaskar (12 Postures)
- Asanas :
  - Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan
  - Supine (Shayansthiti) - Uttan Padaasan(Ekpad/Dwipad), Pavanmuktasana, Viparitakarani Aasan, Khandarasan, Shavasana
  - Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, Saralhasta Bhujangasana, Shalabhasana(Ekpad/Dwipad), Makarasana
  - Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana, Ardh Chakrasana
- Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana - 6 Types
- Pranayama : Anuloma-viloma, Bhramari

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

CO No.	CO	Cognitive level
AC201C.1	Identify and practice some Yoga asanas regularly in their life to remain healthy.	**2**
AC201C.2	Provide guidance and practice about Yoga to their friends, parents and relatives.	**3**

AC-201(D): Introduction to Indian Music **(Personality and Cultural Development Related Audit course; Practical; 2 Credits)** **(Optional: Campus-level)**	
	Course Objectives: • To motivate students towards Indian music and provide them minimum required training. .
	• Definition and brief about generation of Swar, Saptak, Thaat, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc. • Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa. • Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information) • Detailed information of Tambora • Detailed information of Harmonium and Tablaa. • Five filmy songs based on Indian Classical Music (Theory and Presentation) • Sound Management - Basic information of Sound Recording (including Practicals) • Composition of Music as per the Story • Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.

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

CO No.	CO	Cognitive level
AC201D.1	Identify different types of Indian music.	**3**
AC201D.2	Develop more interest to learn and practice Indian music.	**4**

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 (Physics with MS & ES)					
Semester III : Theory Courses					
MS/ES- 301	Atomic and Molecular Physics	Core course	04	100	03
MS/ES- 302	Solid Stats Physics	Core course	04	100	03
MS/ES-303	MS: Elements of Materials Science ES: Renewable Energy	Core course	04	100	03
MS/ES-305	Project	Elective course	04	100	03
Semester III : Practical Courses					
MS/ES-304	Special Laboratory - I	Core course	**04+04**	**100**	**06**
AC-301A/B/C/D	Choose one out of Four (AC-301A/ AC-301B/ AC-301C/ AC-301D) from Technology + Value Added Courses	**Audit course**	**02**	**100**	
Semester IV : Theory Courses					
MS/ES- 401	Nuclear Physics	Core course	**04**	**100**	**03**
MS/ES- 402	MS: Materials Synthesis Methods ES: Solar Photovoltaic Grid Connected Systems	Core course	**04**	**100**	**03**
MS/ES- 403	MS: Characterization of Materials ES: Energy Conversion and Management	Core course	**04**	**100**	**03**
MS/ES- 405	Project	Elective course	**04**	**100**	**03**
Semester IV : Practical Courses					
MS/ES- 404	Special Laboratory - II	Core course	**04+04**	**100**	**06**
AC-401A/B/C/D	Choose one out of Four (AC-401A/ AC-401B/ AC-401C/ AC-401D) from Professional and Social + Value Added Courses	**Audit course**	**02**	**100**	

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

	MS/ES - 301: ATOMIC AND MOLECULAR PHYSICS	
	Course Objectives: ➢ 1. To learn atomic and molecular spectroscopy. ➢ 2. To learn related experiments based on theory and study the practice necessary for solving the problems in atomic and molecular physics.	
Unit 1	**Structure of Atom** Various atomic models- survey-brief ideas with assumptions, postulates and shortcomings, Quantum states of an electron in an atom, Quantum numbers, Electron spin, Stern-Gerlach experiment, Vector atom model- its need/important.	**06 L**
Unit 2	**Atom model for two valence electron** Various coupling schemes: LL, SS, LS and jj, Pauli exclusive principle, Coupling principle, factors for LS coupling , Lande interval rule, JJ branching rule, selection rules, magnetic moment of atom, Lande g factor, Zeeman effect, intensity rules, calculation of Zeeman pattern, Paschen Back effect-LS and jj coupling and Paschen Back effect, Breit's scheme for derivation of spectral terms, Pauli's exclusive	**12 L**

	principle. Stark effect.	
Unit 3	**Complex spectra** Displacement law, alternation law of multiplicities, vector model for more valance electrons, Lande interval rule, inverted terms, Hund's rule, Zeeman effect and magnetic quantum numbers in complex spectra, magnetic energy and Lande g factor	**06 L**
Unit 4	**Hyperfine structure** Introduction, hyperfine structure and Lande interval rule, nuclear interaction with one valance electron, hyperfine structure of two or more electron, Zeeman effect in hyperfine structure, Back Gouldsmit effect in hyperfine structure	**06 L**
Unit 5	**Pure rotational Structure** Rotation of linear system (classical and quantum mechanical), rigid rotator, rotational energy levels and their populations, interaction of rotation with rotating molecules, rotational spectra of rigid rotators, selection rules for linear molecules, determination of moment of inertia and bond length from rotational spectra, isotope effect on rotational spectra, relative intensities of spectral lines	**10 L**
Unit 6	**Pure vibrational spectra** Vibrations of two particles connected by spring (classical), Harmonic oscillators, vibrational energies of diatomic molecules, interaction of radiation with vibrating molecules, an-harmonic oscillator, deduction of molecular properties from vibrational spectra of diatomic molecules	**06 L**
Unit 7	**Rotation and vibration spectra** Diatomic vibrating rotator coupling of rotation and vibration , rotation-vibration spectra, selection rules and transition for vibrating rotator, intensities in rotation and vibration spectrum, parallel and perpendicular bands of linear molecules, Isotope effect-vibration.	**04 L**
Unit 8	**Electronic spectra of diatomic molecules** Electronic energy curves, potential energy curves stable and unstable molecular states, vibration structure of electronic transitions, general formula, graphical representation, isotopes effect, rotational structure of electronic spectra, the branches of band, band head formation and shading of bands: Fortrat diagram, intensities in electronic bands-Vibrational structure-Frank Condon principle, absorption and emission, rotational structure, transition	**10 L**

Suggested readings:

1. Introduction to atomic and nuclear physics (Van Norstrand Reinhold (east- West Press) by H. E. White)
2. Introduction to atomic spectra (Mc. Graw hill, International Edition) by H. E. White)
3. Atoms and Molecules: An introduction for students of Physical chemistry (W. A. Benjamin Inc. New York) by Martin Karplus and Richard N. Porter)
4. Atomic physics, (Oxford Master Series in atomic, optical and laser physics) by Christopher J. Foot.
5. Introduction to atomic spectra (Mc. Graw hill, International Edition) by H. E. White
6. Molecular structure and spectroscopy, 2 nd edition (PHI learning Pvt. Ltd. New Delhi) by G. Aruldhas
7. Fundamentals of Molecular Spectroscopy (McGraw-Hill Publishing Company by Colin Banwell).

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C301.1	Describe the atomic spectra of one and two valance electron atoms.	**1**
C301.2	Explain the change in behavior of atoms in external applied electric and magnetic field	**2**
C301.3	correlate rotational, vibrational, electronic and rotation-vibration spectra of molecules	**4**

	MS/ES - 302: Solid State Physics	
	Course Objectives: ➢ 1. To understand the different theories of specific heat, conductivity and band theory of solids. ➢ 2. To understand the classical and quantum theory concepts of magnetization, polarization superconductivity etc. of materials.	
Unit 1	**Specific heat and lattice vibrations** Classical theory of specific heat and it's drawbacks, Einstein theory of specific heat, vibrational modes of a continuous medium, Debye approximation, The Born cut-off procedure, Vibrational modes of a finite one-dimentional lattice of identical and diatomic lattice.	**08 L**
Unit 2	**Free electron theory of metals** The free electron theory of metals, electronic specific heat, Response and relaxation phenomena, Drude model of electrical and thermal conductivity, the Fermi surface, electrical conductivity; effects of the Fermi surface, Fermi surfaces: its characteristics	**08 L**
Unit 3	**The Band Theory of Solids** The formation of bands in solids, The Bloch theorem, The Kronig-Penny model, The motion of electrons in one dimension according to the band theory, the distinction between metals, insulators and intrinsic semiconductors, the concept of a hole. Brillouin zones	**08 L**
Unit 4	**Dielectric and Optical Properties of Insulators** Static fields: Macroscopic description of the static dielectric constant, The static electronic and ionic polarizabilities of molecules, Oriental polarization, The internal field according to Lorentz and the Clausius-Mosotti formula. Alternating fields: The complex dielectric constant and dielectric losses, dielectric losses and relaxation time, The Classical theory of electronic polarization and optical absorption. Ferroelectricity: General properties of ferroelectric materials, classification, ferroelectric domains	**12 L**
Unit 5	**Magnetism** Magnetic materials and their properties, Quantum theory of paramagnetism, Diamagnetism, Ferromagnetism: The Weiss molecular field and its interpretation, Temperature dependence of spontaneous magnetization. Antiferromagnetism: Molecular field theory, two sub lattice model.	**12 L**
Unit 6	**Superconductivity** Introduction, Meissner effect, The critical field, Thermodynamics of superconducting transition: The heat capacity and stability of superconducting state, Electrodynamics of superconductors: The London equation, coherence length and penetration depth, BCS	**12 L**

	theory of superconductivity, the condensate, The Josephson Tunneling: DC and AC effect, Introduction to high Temperature superconductivity.	

Suggested readings:

1. J. Dekker, Solid State Physics, Macmillan India Limited, 1991.
2. Charles Kittel, Introduction to Solid State Physics, , John Wiley and Sons.
3. H. P. Myers, Viva Books Private Limited, Second Edition.
4. N. W. Ashcroft and N. D. Mermin, Solid State Physics, CBS publishing Asia Ltd.
5. M. Ali Omar, Elementary Solid State Physics, Pearson Education.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C302.1	Explain the basic theories governing the different properties of solids.	**2**
C302.2	Students will be able to establish various theories of different classes of solids showing varying properties like magnetism, polarization and superconductivity	**3**
C302.3	evaluate the basic theories to real problems	**5**

	ES-303: RENEWABLE ENERGY	
	Course Objectives: ➢ 1 to understand the different forms of renewable energy sources. ➢ 2. to understand applications of these sources and their impact on the environment.	
Unit 1	**Introduction to energy studies** Importance of energy, various relevant definitions, Energy and development of society, various external and internal, kinetic and potential energy forms, types of fuels, the Sun, solar radiation, extra-terrestrial distribution of solar radiation, atmospheric attenuation, apparent motion of sun, sunrise, sunset, day length, instruments for measuring solar radiation.	**12 L**
Unit 2	**Fuel cells and hydrogen energy** Concept and characterization of fuel cells, electrochemistry basics, alkaline fuel cells, phosphoric acid fuel cells, components, characteristics, merits, demerits and application of fuel cells. Production of Hydrogen (electrochemical, thermo-chemical, fossil fuels, solar energy methods), characteristics, storage, transportation, utilization of hydrogen, safety and Energy management issues	**12 L**
Unit 3	**Wind energy** Energy in wind, Principle of wind energy conversion into useful energy, power in wind, wind velocity and height from ground, types and components of Wind Energy Conversion Systems (WECS), application, merits and demerits of WECS, dependence of wind power on various factors, criteria of site selection for installation of WECS	**12 L**
Unit 4	**Hydel energy** Hydel Energy, concept and operation hydroelectric energy, scenario of hydroelectric energy in India, classification of hydropower schemes, various types of hydroelectric	**12 L**

	turbines, properties, advantages, applications.	
Unit 5	**Bio energy** Biomass and its conversion to useful energy, photosynthesis, Biogas generation, designs of Biogas plants, use of biogas as a fuel, site selection criteria for biogas plant, thermal gasification of biomass, types and operation of gasifiers.	**12 L**

Suggested readings:

1. Pattern of Energy use in developing countries by Ashok V. Desai,Wiley Eastern Limited.
2. Solar Energy by S P Sukhatme.
3. Fuel Cells by B. Viswanathan, M. AuliceScibioh, Universities press.
4. Non-Conventional Sources of Energy by G. D. Rai, Khanna Publishers.
5. Wind Energy Systems by G. L. Johnson, Kansas State University

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C303.1	Students will memorize the basic theories of different renewable energy sources	**1**
C303.2	Explain technical aspects in these sources	**2**
C303.3	Manage the energy crisis amongst premises	**6**

	MS-303: Elements of Materials Science	
	Course Objectives: ➢ The important objective of this course is to explore the fundamental properties of various materials including metal, ceramics and insulators. ➢ This course is also deal with various applications of materials.	
Unit 1	**Classification of Materials** Classification of Engineering Materials, Selection of materials, Level of structure, Modern material needs, structure-property relationship in materials	**03 L**
Unit 2	**Properties of materials** Mechanical properties: Mechanical fundamentals, isotropy and anisotropy, stressand strain, hooks law and modulus of materials, Poisson's ratio, stress-strain relation, Important properties: strength, Elasticity, fatigue, ductility, toughness, stiffness, malleability, plasticity, hardness, brittleness, factors affecting mechanical properties. Electrical properties: Resistivity, conductivity, Ionic conductivity, Superconductivity, Insulators, Semiconductors, factors affecting conductivity. Thermal properties: Melting point, Thermal Shock, Heat capacity, Specific heat, Thermal expansion and thermal conductivity. Optical properties: Electromagnetic radiation, refraction, reflection, absorption, transmission, color. Magnetic properties: magnetization, magnetic moments, dipoles, magnetic domain, diamagnetism, paramagnetism, ferromagnetism,ferrimagnetism, susceptibility and	**13 L**

	curie temperature, hysteresis loss, Ferrites	
Unit 3	**Phase diagram** Single and multi-phase solids, solid solutions, factors governing the solid solubility (Hume Rotheryrules for primary solid solution), inter-metallic compounds, valency compounds, electron compounds, interstitial compounds, Phase diagrams: Phase rule, Unary and binary phase diagram, construction of phase diagram, Lever rule, interpretation of phase diagram, Isomorphous system, eutecticsystem, eutectoid system, peritectic system, micro structural diagram developments: Study of Pb-Sn, Fe-C, Cu-Ni phase diagram	**12L**
Unit 4	**Metallurgical thermodynamics and phase transformation** Thermodynamic origin of phase diagram, Crystal, grain and grain boundary, Solidification and crystallization, nucleation, nucleation rate, crystal growth, rate of crystal growth, surface energy, critical radius inheterogeneous and homogenous nucleation, allotropic transformation	**08L**
Unit 5	**Polymeric materials** Basic concepts of polymer, size of polymer, mechanisms of polymerization, molecular weight, molecular shape, structure, configuration, crystallanity, mechanical, optical and thermal properties of polymers, electrical properties - conducting polymers	**08 L**
Unit 6	**Ceramics** Classification of ceramics, structure of ceramics, silicates structure, polymorphism of ceramics, mechanical, thermal and electrical properties of ceramic phases, clay and clay materials	**04L**
Unit 7	**Advanced materials** **a) Nanomaterials:** Concept of nanomaterials, electron confinement in infinitelydeep square well, confinement in two and one dimensional well, idea ofquantum well structure, quantum dots, mechanical, electrical, thermal, magnetic and optical properties of nanomaterials. **b) Composite materials:** Concept of composite, Types of composite, agglomerated materials, reinforce material, Surface coating: Laminates, metallic coatings. **c) Materials for Solar energy:** Photovoltaic materials: Inorganic materials (Si, GaAs), Organic materials, perovskite, photothermal: selective coatings	**12L**

Suggested readings:

1) Material Sciences and Process, S. K. Hajara-Chaudhari, Indian BookDistributing Co.
2) Material Science and Engineering, W.D. Callister, Jr. W, Wiley InternationalEditions, 2003.)
3) Material Science and Engineering , V. Raghavan, Prentice Hall of India Pvt. Ltd., New Delhi.
4) Physical Metallurgy Part I and II, Edited by R. W. Cahn and H_Haasan, NorthHolland, 1983.
5) Phase transformation in metals and allys, david A. Porter and K.E. Easterling,(Van NostarndRcinhold Co., Newyork).
6) Nano: The essentials – Understanding Nanoscience and Nanotechnology, T.Pradip, Tata Mac Graw Hills
7) Nanotechnology, Booker and Boysen, Wiley.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C303.1	Explain various fundamental properties of materials.	**2**
C303.2	Conclude physics behind thermodynamics and alloy formation	**4**
C303.3	Recognize the basics of advanced materials	**1**

MS/ES - 304: Special Laboratory - I

Course Objectives:

- to understand and correlate results of experimentations as well as theory.
- To get the thorough fundamental knowledge of practical's particularly based on the specializations.
- To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

COMMON EXPERIMENTS

1. Determination of Curie temperature of given magnetic material.
2. Determination of e/m ratio of an electron.
3. Determination of Susceptibility: Gouy's Method.
4. Determination of Hall Coefficient and mobility (Hall Effect).
5. Measurement of waves by Ultrasonic Interferometer.
6. Study of Active Band Pass Filter using electronic circuits.

EXPERIMENTS IN MATERIALS SCIENCE

1. To determine the dielectric Constant of $BaTiO_3$.
2. To study the Phase diagram of Pb-Sn alloy.
3. To study the Hysteresis loop for Ni material.
4. Measurement of Heat Capacity of different metals.

EXPERIMENTS IN ENERGY STUDIES

1. Effect of tilt of solar module and Series and Parallel combination of SPV modules.
2. To study of emissivity of various metals.
3. To determine phenomenon of heat transfer through lagged pipe.
4. Solar Cell Simulation Using PC1D Simulator.

(*Only ten practical's has to be performed by MS and ES students.)

Suggested readings:

1) Material Sciences and Process, S. K. Hajara-Chaudhari, Indian BookDistributing Co.
2) Material Science and Engineering, W.D. Callister, Jr. W, Wiley InternationalEditions, 2003.)
3) Material Science and Engineering , V. Raghavan, Prentice Hall of India Pvt. Ltd., New Delhi.
4) Introductory Electronic Devices And Circuits- Painter2nd Edition, 1991, New Jerky; Regents/Prentice Hall.
5) PV Lab manual developed by NCPRE, IIT Bombay.

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

CO No.	CO	Cognitive level
C304.1	develop and conduct appropriate scientific experimentation	**3**
C304.2	Analyze and interpret data and use scientific judgment to draw conclusions.	**4**
C304.3	Integrate new knowledge as needed using appropriate experimentation strategies.	**6**

M.Sc. Part II Semester III Physics: Elective Course

	MS/ES - 305: Project	
	Course Objectives: ➢ to facilitate student to carry out extensive research and development project or technical project. ➢ to indentify scientific problem, gap identification, development of methodology for problem solving. ➢ to interpret the findings, presentation of results and discussion of findings in context of national and international research.	

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

CO No.	CO	Cognitive level
C305.1	Memorize in-depth knowledge and use adequate methods in the major subject/field of study.	**1**
C305.2	Critically evaluate different technical/research solutions	**5**
C305.3	Identify the issues that must be addressed within the framework of the specific dissertation in order to take into consideration	**2**

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	**2 hrs**

	/HDD /DVD-ROM/Flash drives, memory measurement metrics	
Unit 2	**Office Automation-Text Processing** 2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View, ReadingLayout View 2.2 Working with Files: Create New Documents, Open Existing Documents, SaveDocuments 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 Lists, 2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Moveand Resize Tables, Moving the order of the column and/or rows inside a table, TableProperties 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.	**5 hrs**
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 hrs**
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 orText box properties, Bulleted and numbered lists, Adding notes 4.3 Work with text: Add text and edit options, Format text, Copy text formatting, Replacefonts, Line spacing, Change case, Spelling check, Spelling options 4.4 Working with tables: Adding a table, Entering text, Deleting a table, Changing rowwidth, 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, slideanimation/transitions.	**6 hrs**
Unit 5	**Internet & Applications:** 5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing theInternet, 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 hrs**
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 (DropBox, Google Drive, Google Docs, Office 365	**3 hrs**

	Prezi, etc.)	

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 hrs**
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 hrs**
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 hrs**

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 hrs**
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 hrs**
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 hrs**
Unit 7	**Security Laws and Standards** Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its amendments.	**3 hrs**

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. CreateSpace 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): C- programming

(Technology + Value added Audit course; Practical; 2 Credits)

(Optional: Campus + Program level)

Course Objectives (CObs):

- to develop the skill of computer language which may help students for solving of numerical problems
- to adapt the knowledge of numerical methods of solving differential equations.

Unit 1	**Basics of C** What is C, History and Importance of C, Getting started with C, The C character set, constant variable and key words, Type of C constant, Rule for constructing: Integer constant, real constant, character constant, variable names, Type of C variables, C key words, first C program, Compilation and execution.	**10 hrs**
Unit 2	**Unit II Decision control statement**	**10**

	If statement, the if-else statement, use of logical operator, loops, the while loop, the for loop, the break statement, the continue statement, the do while loop, decision using switch, switch versus if else ladder.	**hrs**
Unit 3	**Unit-III Arrays and pointers** One-dimensional arrays, passing arrays to functions, multidimensional arrays, strings. Basics of pointers, pointers and one-dimensional arrays, pointer arithmetic, pointer subtraction and comparison, similarities between pointers and one-dimensional arrays.	**10 hrs**
Unit 4	**Programming using C-Language Part -I** **(A) Solving roots by using numerical methods** Numerical solution of algebraic and transcendental equations by simple iteration methods: Bisection method, Regula falsi method (method of false position), Newton-Raphson method. Algorithm and Flowchart **(B) Solution of simultaneous linear system of equations** Iterative method for solving linear equations by Gauss-Jacobi and Gauss-Seidel method. Algorithm and Flowchart.	**10 hrs**
Unit 5	**Programming using C-Language Part -II** **(A) Solving integration** Numerical integration by Trapezoidal rule, Simpson's rules, Gaussian quadrature formulae, Error calculations. Computer implementation for Trapezoidal and Simpson rule. **(B) Solving differential equations** Numerical solution of ordinary differential equation using Taylor Series method, Euler method, Modification of Euler's methods , Runge-Kutta method of order two to four. Error calculation, Computer implementation for RK method.	**10 hrs**

Suggested readings:

1. Jain M.K., Iyengar S.R.K., Numerical methods for Scientific and Engineering Computation, 3rd edition, New Age International (P) Ltd, 1996.
2. Introductory Methods of Numerical Analysis- S. S. Sastri, 2nd Edition, Prentice Hall of India Pvt. Ltd., 1992.
3. V. Rajaraman, Computer oriented numerical methods, 3rd Edition, PHI learning private Ltd., 2008.
4. Madhumangal Pal, Numerical analysis for scientists and engineers: Theory and C program, Narosa publishing house, 2008.
5. Y. Kanetkar, Let us 'C', BPB publication, 2007.
6. E. Balaguruswamy, Programming in ANSI C, McGraw Hill education India Pvt. Ltd, 2017.
7. Byron S. Gottfried, Programming with C, Schaum's outlines, Tata McGraw Hill company Ltd, 2006.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
AC301C.1	Judge the requirement of C-programs independently according to numerical methods.	**2**
AC301C.2	Estimate the solution of differential equations with C programming and numerical methods.	**5**

AC-301(D): Industrial Materials

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

Course Objectives (CObs):

- To develop the knowledge of various materials used in industry
- To gain the relationship between the properties of various materials with their applications

Unit 1	**Requirement of Materials for Industry** Introduction to Industrial Materials, Classification of Materials: Metals/alloys, Ceramic, glasses and glass-ceramic, polymers(plastics), semiconductors and composites, Functional Materials: Aerospace, Biomedical, Electronic materials, Smart materials, Magnetic materials and Energy related materials	**12 hrs**
Unit 2	**Properties of Materials** Mechanical (Stress, Strain and Hardness), electrical (resistivity and mobility) optical (refractive index, transmission and band gap) and magnetic properties (susceptibility and permeability) of materials.	**10 hrs**
Unit 3	**Advanced Materials** Ceramics, Polymers, Composites, Optical materials, Super alloys, Pervoskites, Semiconducting materials.	**08 hrs**
Unit 4	**Nano and Biomaterials** Fundamentals of nanostructured materials, Significance of nanostructured materials, Structural aspects, nano structures, materials for biosensors.	**08 hrs**
Unit 5	**Applications** Metals and alloy, Ceramics: Glasses, Clay product powder and tape casting. Polymers: Plastics, elastomers, optical fibers. Composites: reinforced, laminar and sandwich panel type. Nano materials: CNT, Graphene, Bio-nano sensors. Semiconductors: Integrated circuits, Solar cells.	**12 hrs**

Suggested readings:

1. Materials Science and Engineering: An Introduction, William D. Callister, Wiley (2010)
2. Introduction to Materials Science for Engineers, 8/E; James F. Shackelford, Pearson (2015)
3. The Science and Engineering of Materials, 4thed., Donald R. Askeland and Pradeep P. Phule *Publisher*: Cengage Learning (2010)
4. Instrumental Methods of Analysis, Willard, Merritt, Dean, Setttle, CBS Publishers & Distributors (2004)
5. Principles of Instrumental Analysis, Skoog, Holler, Nieman; Publisher: Brooks Cole; 6 edition (2006).
6. Characterization of Materials, Eliton N. Kauffmann, Wiley (1999).

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
AC301D.1	Explain various properties of materials required for particular scientific application.	**2**
AC301D.2	Interpret the material property relationship in detail.	**3**
AC301D.3	Estimate necessity of materials for industry applications.	**3**

	MS-401: Nuclear Physics	
	Course Objectives: ➢ to provide students with an understanding of basic radiation interaction. ➢ Explore the fundamental principle of detection techniques for nuclear physics ➢ In addition to gain in-depth knowledge of radioactive decays, nuclear reactions and elementary particle physics etc.	
Unit 1	**Nuclear Properties and its concept** Introduction: Constituent of Nuclei and its Mass, Nuclear forces, Stability of Nuclei, Nuclear Mass Radius, Mass defect and Packing fraction, Systematic of Nuclear Binding Energy and Stability, Nuclear Magnetic Dipole Moments, Electric Quadrupole moment.	**06 L**
Unit 2	**Nuclear models** Introduction, Liquid drop model: Semi-empirical mass formula, Applications of semi-empirical mass formula, Limitations of liquid drop model, Shell Model- Predictions of the Shell Model, Achievements & Failures of shell Model, Collective Model	**08 L**
Unit 3	**Radioactivity** Introduction, Law of radioactive disintegration, Units of Activity, Law of radioactive decay constant, Basic concepts of half life, mean lifetime of nuclei, Theory of successive transformation, Radioactive equilibrium, Radioactive dating methods. Production of various radioisotopes and its Application in various fields, Alpha particle energy and Geiger-Nuttal law, Neutrino hypothesis, The Fermi theory of beta-decay, selection rule for beta decay, Gamma ray spectra, radioactive transitions in nuclei for gamma decay	**12 L**
Unit 4	**radiation detectors** Introduction, Interaction of charged particle with matter, Ionization and transport phenomena in gases, Ionization chamber, Proportional counter, GM counter, Scintillation detector, Semiconductor detector, Bubble Chamber, Cloud Chamber	**08 L**
Unit 5	**Mass Spectrograph and nuclear accelerators** Introduction, Mass spectrograph, Brain bridge Mass Spectrograph, The van de Graff generator, Cyclotron, Betatron, Electron synchrotron, Proton synchrotron, Linear accelerator	**06 L**
Unit 6	**Reaction dynamics, nuclear reactors** Introduction, Types of Nuclear Reactions: Nuclear fission, Fission Chain Reaction, Conservation Laws in Nuclear Reactions, Q-value of Nuclear Reaction, Compound Nucleus Hypothesis, Four Factor Formula, Multiplication Factor, Nuclear fusion, the plasma, Stellar energy, Basic design of Nuclear Reactor, List of Different Types of Reactors Developed in India	**08 L**
Unit 7	**Elementary particles** Classification of Elementary Particles, Decays of Elementary Particles, Fundamental interactions in nature, Concept of force carrier, Yukawa Potential of interaction, Conservation Laws of elementary particles, Gelmann-Nishijima formula, Elementary idea about CP and CPT invariance, Quarks Model: Classification and properties of quarks, Strong isospin, Strange quark, Quark structure in meson and baryons, Quantum Chromodynamics and electrodynamics, Gellman-Okubo mass formula	**12 L**
Suggested readings:		

1. K.S.Krane, 1988, Introductory Nuclear Physics, Wiley, India.
2. B.L.Cohen, Concepts of Nuclear Physics, Tata McGraw Hill.
3. I.Kaplan, 1989, Nuclear Physics, 2nd Edition, Narosa, New Delhi.
4. S.N.Ghoshal, Atomic and Nuclear Physics, S. Chand.
5. D.C.Tayal, Nuclear Physics, Himalaya Publishing House.
6. R.D.Evans, The Atomic Nucleus, Tata McGraw Hill.
7. S. S. Kapoor and V. S. Rmanurthy. Nuclear radiation detectors (Wiley Eastern Limited, New Delhi,) 1986.
8. G.F.Knoll, Radiation Detection and Measurement, 3rd edition, Wiley India.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C401.1	Describe the basic interaction mechanisms for charged particles and electromagnetic radiation and explain the working principles behind detectors and their characteristic properties with respect to energy resolution, efficiency etc.	**2**
C401.2	Identify the mechanism and kinematics of nuclear reactions	**1**
C401.3	Describe the basic features involved in alpha and beta decays and nuclear forces	**2**

	ES-402: Solar Photovoltaic grid connected systems	
	Course Objectives: ➢ to make students acquainted with grid connected solar photovoltaic systems. ➢ to enable students to develop insights into components of the system as well as design and installation of such systems.	
Unit 1	**Solar photovoltaic cells and modules** Factors affecting performance of solar cells: temperature, irradiance; Types of solar cells: Crystalline(Monocrystalline and polycrystalline),Thin film solar cells (a-Si, CIS, CdTe); structure of a solar module, Electrical protection (Bypass diodes, blocking diodes)	**08 L**
Unit 2	**INVERTERS** Purpose of inverters, Grid connected inverters Vs stand alone inverters, types of grid connected inverters, PV to inverter interface, inverter protection systems, power quality, monitoring, inverter efficiency	**09 L**
Unit 3	**Mounting system and balance of system** Introduction, calculating the wind loading, roof mounted systems, PV array row spacing, ground mounted systems BOS: Introduction, cabling, array string protection and disconnect switches, lighting protection, array junction box, PV main disconnection devices, metering, system monitoring	**09 L**
Unit 4	**Site assessment and pre-installation decisions**	**09 L**

	Introduction, undertaking a site assessment, choosing PV module, choosing inverter, choosing mounting system type, determining maximum number of modules that can fit on the roof	
Unit 5	**Inverter matching and system protection** Matching PV array to Voltage, current and power rating of the inverter, Example. Determining the protection equipment and switching, PV array maximum voltage, circuit protection: over current, Disconnection devices, system earthing, connecting the system to grid	**09 L**
Unit 6	**Cable sizing and system installation** Determining the size of DC and AC cables: current carrying capacity, voltage drop and power losses, Standards, equipment selection, installation preparation, equipment installation, monitoring equipment and signage	**08 L**
Unit 7	**Economics of grid connected systems** Introduction, simple payback, lifecycle costing, cost of total PV system, valuing a PV system	**08 L**

Suggested readings:

1. Grid Connected PV Systems Design and Installation Published by Global Sustainable Energy Solutions 1st edition.
2. Grid-Connected Photovoltaic Power Generation: Technologies, Engineering Economics, and Risk Management1st edition by Peter Gevorkian Cambridge University Press.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C402.1	Interpret the concept of grid connected solar photovoltaic systems	**3**
C402.2	Evaluate different parts of the system with their required specifications	**5**
C402.3	Formulate different aspects related to designing and installation of the system	**6**
	Identify the economic aspects of the system	**1**

	MS-402: Materials Synthesis Methods	
	Course Objectives: ➢ to create an awareness of various material synthesis techniques. ➢ to facilitates the new insights as well as explores the fundamental principles of various materials synthesis techniques. ➢ to correlate material properties with experimental synthesis techniques.	
Unit 1	**Bulk materials synthesis** Importance of the materials and methods, formation of thin and thick films with application, Synthesis of Bulk (Powder form) Materials: Basic concept, process description, preparation, blending of powder, compacting and sintering, advantages and disadvantages, application of the bulk material and a case study	**06 L**
Unit 2	**Crystal growth** Importance of growing crystals and their applications, thermodynamic theory of crystal	**08 L**

	growth. Growth from solution methods: growth from water solution, gel method, flux method, hydrothermal method Growth from melt methods: Czochralski crystal pulling (CZ), Bridgman-Stockbarger technique	
Unit 3	**Thick film deposition** Screen Printing: Basic aspects of the process, experimental set-up, substrate materials, screen printing and firing process, advantages and disadvantages, a case study. Doctor blade: Basic aspects of the process, experimental set-up, substrate materials, need of annealing step, advantages and disadvantages, a case study	**06 L**
Unit 4	**Thin film deposition** Brief introduction regarding different methods for thin film formation (Physical and chemical) **CHEMICAL METHODS:** Chemical bath deposition (CBD) method: Introduction, experimental set-up, basic requirements, basic mechanisms: ion-by-ion, hydroxide cluster and complex decomposition mechanism, deposition from acidic bath, effect of stirring, advantages and disadvantages, a case study of CdS deposition, size quantization in CD films. Brief idea about SILAR (Successive ionic layer adsorption and reaction) method, advantages over CBD **ELECTROCHEMICAL DEPOSITION:** Introduction, principle, Faradays laws of electrolysis, experimental set-up, electrode, electrolyte, additives, power supply, substrate, Classification of elctrodeposition: potentiostatic, galvanostatic and cyclic voltametry, Steps involved in electrodeposition process, nucleation and growth mechanism, advantages and disadvantages, a case study **SPRAY PYROLYSIS:** Principle, experimental set-up, preparative parameters: influence of temperature, precursor's solution, Model for films deposition: Atomization of precursor's solution, Aerosol transport, decomposition of precursor, advantages and disadvantages, a case study of SnO_2 deposition **SPIN COATING:** Introduction, experimental set-up, Modeling spin coating, advantages and disadvantages, a case study	**09 L** **08 L** **06 L** **03L**
Unit 5	**Physical methods** Introduction, physical vapor deposition (PVD) and Chemical Vapor deposition (CVD), Evaporation Methods: Thermal Evaporation (vacuum evaporation), Flash evaporation, Laser evaporation, Molecular beam epitaxy, Chemical Vapor Deposition: Basic aspects of CVD, reactions in CVD, Types of CVD: atmospheric pressure, low pressure, plasma enhanced CVD. Sputtering: Basic principle of sputtering process, brief regarding triode sputtering, ion beam sputtering	**14 L**

Suggested readings:

1. Thin Film Phenomenon, K. L. Chopra, Mc Graw Hill, 1969.
2. Hand Book of Thin Film Technology, L. I. Maissel and R. Glang Mc Graw Hill, 1969
3. Thin Film Processes. J. L. Vossen and W. Kem, (Academic Press, 1978)
4. The Material Science of Thin Films, M. Ohring (Academic Press, 1972)
5. Chemical Solution Deposition of semiconductor Films, Gary Hodes, Marcel Dekker Inc
6. Thin Film Deposition Using Spray Pyrolysis, J. Electroceramics, 14 (2005) 103-111

7. Nanotechnology: Principles and Practices, Kulkarni, Sulabha K. 3rd ed. 2015, Springer.
8. Preparation of Thin Films, Joy George, Marcel Dekker, Inc.
9. Handbook of semiconductor electrodeposition, R.K.Pandey, S.N.Sahu, S.Chandra
10. Spin Coating for rectangular substrates, A Thesis written by G. A. Luurtesema, University of California, Berkeley, 1997.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C402.1	Recognize the fundamental processes of material synthesis	**1**
C402.2	Apply the knowledge of bulk material, thin and thick film in daily practices	**3**
C402.3	Recommend different materials synthesis techniques for scientific purpose	**5**

	ES-403: Energy Conversion and management	
	Course Objectives: ➢ to make students acquainted with various solar collectors. ➢ to enable students to develop insight into components of the system as well as design and installation of such systems. ➢ to gives knowledge of the energy auditing process and implementation of energy conservation and motivation to the workers in industrial sector	
Unit 1	**Solar flat plate collector** Introduction, Design and structures of collectors for heating liquids and air, Energy balance equation, trasmissivity of cover systems, trasmissivity absorptivity product, overall loss coefficient and heat transfer correlations, Liquid flat plate collectors: collector efficiency factor, collector heat removal factor, testing procedure; the evacuated tube collectors	**12 L**
Unit 2	**Solar concentrators** Introduction to concentrating collectors: classification and types, Concentration ratio, Acceptance angle, Stationary collectors: Compound parabolic collectors, Sun-tracking collectors: parabolic trough collector, Fresnel collector, parabolic dish reflector, Heliostat field collectors; optical and thermal performance of a concentrating collector	**12 L**
Unit 3	**Energy audit and energy economics** The energy audit concept, elements of energy audit, process of energy audit and preparation of energy audit report, investment analysis for an energy conservation scheme, generation of funds for energy conservation schemes, interest and depreciation, types of depreciation, economic life, salvage value, payback value	**12L**
Unit 4	**Employee motivation in organizations and process management** The Human factor, energy conservation and people, the involvement tree, elements of energy management programme, promoting energy conservation, programme planning, programmeimplementation, steps for process improvement, motors and adjustable speed drives, common energy management opportunities, steps for process	**12L**

	improvements, motors and drives, compressors, energy conservation opportunities	
Unit 5	**Energy conservation and thermal insulation and lighting** Propagation of heat in material, conduction, convection, radiation losses, properties desirable in insulating materials, various insulators, economical thickness of insulators, selection of insulating materials Components of lighting system, lamp types, luminaires, determining lighting needs, maintaining the lighting systems	**12 L**

Suggested readings:

1. Guide to Energy Management and Utilization by B. Caphart, W. C. Turner, W. J. Kennedy, The Fairmount Press.
2. Industrial Energy Management and Utilization by L. C. Witte, P. S. Schmidt, D. R. Brown, Hemisphere Publishing Company.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C403.1	Recognize the concept of solar collectors	**1**
C403.2	Identify in detail different parts of the system with their required specifications	**2**
C403.3	Classify different aspects related to the energy audit and energy conservation for scientific purpose	**4**
C403.4	Discover the economic aspects of the energy	**2**

	MS-403: Characterization of Materials	
	Course Objectives: ➢ to learn various material characterization techniques. ➢ to facilitates students with the new insights of characterization techniques. ➢ to explores the fundamental principles behind various characterization techniques with their practical applications	
Unit 1	**IR AND UV- Visible spectroscopy** Range of IR absorption, requirement for IR radiation absorption, theory of IR absorption spectroscopy, linear molecules, symmetric molecules, asymmetric molecules, Instrumentation, FTIR: principle, application, limitations, Color and light absorption, the chromospheres concept, theory of electronic spectroscopy-orbital's involved in electronic transitions, laws of light absorption,- Beer's and Lamberts law, Instrumentation, UV-spectrophotometer, sample and reference cells, application of UV-Vis spectroscopy, Band gap determination (Direct , Indirect) for thin films	**12 L**
Unit 2	**Raman spectroscopy** Characteristic properties of Raman lines, differences between Raman spectra ad infrared spectra, mechanism of Raman effect, instrumentation, intensity of Raman lines, Application of Raman spectroscopy	**10 L**
Unit 3	**X-ray diffraction** Crystalline state, X-ray diffraction process, preliminary discussion, instrumentation and single crystal pattern, and their information content, structure and structure factor determination, particle size determination, crystallography by diffraction of	**12 L**

	radiations other than X-ray, application of X-ray diffraction measurement and analysis	
Unit 4	**Electron microscopy** Why uses electrons? Electron lenses? factors limiting the performance of electromagnetic lenses **Transmission electron microscopy (TEM):** Constituent parts and their functions with attachments, selected area, high resolution, reflection and scanned diffraction, dark field electron microscopy, reflected electron microscopy, X-ray microanalysis quantitative interpretation of crystalline image contrast. **Scanning electron microscopy (SEM):** History, signal detection, equipment, nature of SEM image, secondary electron emission: the distribution of emitted secondary, selection of secondary in SEM, secondary electron yield, effect of angle, voltage and field contrast, specimen charging effect, factors affecting resolving power of SEM, relation between working distance, final aperture size and beam divergence in SEM. Energy dispersive X-ray spectroscopy (EDS): principle, instrumentation, sample analysis, limitations	**10 L** **12 L**
Unit 5	**Atomic force microscopy** Operating principle, Different operating modes: Contact, tapping, non-contact, forces between the tips and surfaces, limitations of AFM	**04 L**

Suggested readings:

1. Elements of X-ray diffraction: Cullity, Addision-Wesely Publishing Comp, USA.
2. Encyclopedia of Materials Characterization, (Series): Richard Brundle, Charles A Evans, Jr Shaun Wilson, Surface, Interfaces,
3. SEM Characterization of semiconductors: B. Holt, and D.C. Joy, Academic Press, New Delhi
4. Fundamental of molecular spectroscopy: Banwell, Tata McGraw-Hill Publ. Company Ltd New Delhi
5. Electron Microscopes: J. A. Swift
6. Introduction to Diffraction in Materials Science and Engineering: Aaron D Krawitz, John Willey and Sons Inc
7. Atomic Force Microscopy: Cheryl R Blanchard, The Chemical Education, 1/vol.

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C403.1	Describe the fundamental processes of advanced material characterization techniques	**1**
C403.2	Explain various applications of these techniques in pure material science	**3**
C403.3	Compare various aspect associated to characterization techniques	**5**

	MS/ES - 404: Special Laboratory - II	
	Course Objectives: ➢ To learn the principles of material testing and characterization and to apply them for various scientific applications. ➢ To correlate knowledge of specialized materials science and energy studies practical's with their theory. ➢ To learn how the energy crises can solve by studding the solar cell ➢ experiments. ➢ To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.	
	COMMON EXPERIMENTS 1. To study the Thermionic emission properties of tungsten wire. 2. To study the atomic energy levels by Franck-Hertz Experiment. 3. Determination of Susceptibility: Quinck's Method. 4. To study the effect of temperature on various electronic properties by Hall effect set-up. 5. To study the operation of single-stage and multi-stage RC–Coupled Amplifier. 6. To study the effect of load resistance & source resistance on operation of an amplifier. **EXPERIMENTS IN MATERIALS SCIENCE** 1. Determination of optical band gap using UV Visible spectroscopy. 2. Analysis of X-ray Diffraction pattern for determination of crystal structure. 3. Synthesis of thin films by spin coating method. 4. To study the optical properties of semiconducting film by Photoluminescence spectroscopy. **EXPERIMENTS IN ENERGY STUDIES** 1. To study the efficiency measurement of stand-alone solar PV system. 2. To study the efficiency of Flat Plate Collector (Forced circulation mode). 3. To carry out the measurement study of available solar energy. 4. To calculate the Figure of merit of solar cooker. (*Only ten practical's has to be performed by MS and ES students.)	

Suggested readings:

1. Introduction to Diffraction in Materials Science and Engineering: Aaron D Krawitz, John Willey and Sons Inc.
2. Elements of X-ray diffraction: Cullity, Addision-Wesely Publishing Comp, USA.
3. Encyclopedia of Materials Characterization, (Series): Richard Brundle, Charles A Evans, Jr Shaun Wilson, Surface, Interfaces.
4. Hand Book of Thin Film Technology, L. I. Maissel and R. Glang Mc Graw Hill, 1969

Course Outcomes (COts):

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

CO	CO	Cognitive

No.		level
C404.1	Prepare the specimens with the help of various synthesis techniques independently.	**3**
C404.2	Classify the different materials based on their characterization techniques.	**4**
C404.3	Apply various test methods for characterizing physical properties of materials	**3**
C404.4	Gain sufficient knowledge necessary for construction and designing of various solar based devices.	**6**

M.Sc. Part II Semester IV Physics: Elective Course

	MS/ES - 405: Project	
	Course Objectives: ➢ to carry out necessary in-depth research/technical work in particular broad scientific area. ➢ To compare the status of present research work in national and international level and to conduct thorough discussion of research findings. ➢ The overall goal of the project/dissertation is to express the knowledge and capability particularly required for independent work.	

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
C405.1	clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings	**2**
C405.2	Apply the observed solutions for real time problems associated in society	**3**
C405.3	adapt the knowledge and skill necessary for scientific report preparation as well as presentation	**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: Campus-level)**	
	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 hrs.**
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. 2.2 Constitutional Provisions for Human Rights 2.3 Declaration of Human Rights 2.4: National Human Rights Commission	**8 hrs.**
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 hrs.**
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 hrs.**
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: Campus-level)		
	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): Review of Research Papers

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

Course Objectives (CObs):

- To develop the skill in students to search the scientific articles in the field of Materials Science and Energy studies.
- To motivate students for the scientific review of research papers in the broad field of Physics.

Review of Research Papers:

- Modes of Literature Survey:
  - 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.)
  - Writing the summary of research paper: 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.)

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
AC401C.1	Analyse the scientific content in form research paper.	**4**
AC401C.2	Establish the scientific information on a topic of interest and further similarity of scientific content (plagiarism) will be checked.	**3**
AC401C.3	Express his scientific knowledge in the form of presentation/discussion with confidence.	**2**

	AC-401(D): Fundamentals of Electric Vehicles: Technology and Economics (NPTEL online course) **(Optional: Program-level)**	
	Course Objectives (CObs): ➢ The course will examine technology associated with each element of EV drive-train ➢ The course will get into economics of EVs in India and petrol vehicles.	
01	Can India Drive its EV Program Innovatively and Differently and Scale?, Can India Drive its EV Program Innovatively and Differently and Scale? (cont.), A Bit about Batteries, Charging and Swapping Infrastructure, Where will We Get Lithium for Batteries?, EV Subsystems	**Week 1**
02	Forces Acting When a Vehicle Move, Aerodynamic Drag, Rolling Resistance and Uphill Resistance, Power and Torque to Accelerate, Putting it All Together 1, Putting it All Together 2, Concept of Drive Cycle 1	**Week 2**
03	Concept of Drive Cycle 2, Drive Cycles and Energy Used per Km, Part 1, Drive Cycles and Energy Used per Km, Part 2, EV Subsystem: Design of EV Drive Train, Part 1, EV Subsystem: Design of EV Drive Train, Part 2	**Week 3**
04	Introduction to Battery Parameters, Part 1,Introduction to Battery Parameters, Part 2, Why Lithium Ion Battery? (Part 1), Why Lithium Ion Battery? (Part 2), Batteries in Future, Li-Ion Battery Cells,	**Week 4**
05	SoH and SoC Estimation and Self Discharge, Part 1, SoH and SoC Estimation and Self Discharge, Part 2, Battery Pack Development, Part 1, Battery Pack Development, Part 2, Computation of Effective Cost of Battery, Part 1, Computation of Effective Cost of Battery, Part 2, Charging Batteries,	**Week 5**

06	Fundamentals of Battery Pack Design, Mechanical Design, Part 1,Mechanical Design, Part 2, Mechanical Design, Part 3,Mechanical Design, Part 4, Thermal Design, Part 1, Thermal Design, Part 2,Thermal Design, Part 3,	**Week 6**
07	Thermal Design, Part 4, Electrical Design, Part 1, Electrical Design, Part 2, Electrical Design, Part 3, BMS Design of Electric Vehicle, Part 1, BMS Design of Electric Vehicle, Part 2, BMS Design of Electric Vehicle, Part 3, EV Motors and Controllers: Understanding Flow, Part 1, EV Motors and Controllers: Understanding Flow, Part 2,	**Week 7**
08	Power and Efficiency, Torque Production, Part 1, Torque Production, Part 2, Torque Production, Part 3 Speed and Back EMF, The d-q Equivalent Circuit, Part 1, The d-q Equivalent Circuit, Part 2, Field-Oriented Control, Three Phase AC, Part 1, Three Phase AC, Part 2, Thermal Design, Part 1, Thermal Design, Part 2 Engineering Considerations, Part 1, Engineering Considerations, Part 2, Future Frontiers, EV Chargers: Introduction, EV Chargers: Slow or Fast, Part 1, EV Chargers: Slow or Fast, Part 2, Battery Swapping, Standardization and On Board Chargers, Public Chargers, Part 1, Public Chargers, Part 2, Bulk Chargers/ Swap Station, Part 1, Bulk Chargers/ Swap Station, Part 2, Economics of Public Chargers in Context, Analytics, Part 1, Analytics, Part 2, Course summary	**Week 8**

Suggested readings:

1. Fundamentals of Electric Vehicle Technology: A DIY Guide for EV Beginners (DIYguru) Kindle Edition, DIYguru; 1st edition (2 May 2020) Avinash Singh, Aayush Chimurkar, Anubhav Sen, Nikhil Raj, Ashutosh Kumar.
2. Electric Powertrain – Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles by John G. Hayes and A. Goodarzi, Wiley Publication.
3. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Fundamentals, Theory, and Design, Mehrdad Ehsani, Texas A&M University Yimin Gao, Texas A&M University Sebastien E. Gay, Texas A&M University Ali Emadi, Illinois Institute of Technology, CRC Press.

****** The above course is archived, students have to be learned the course from the Videos (available on NPTEL Site) of said lectures in online mode (only) and then evaluation will be done by Faculty of Department of Physics, KBCNMU Jalgaon.*

Course Outcomes (COts):

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

CO No.	CO	Cognitive level
AC401D.1	Interpret the technology associated with each element of an EV drive-train	**2**
AC401D.2	Estimate economics of EVs in comparison with petrol-powered vehicles.	**5**

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