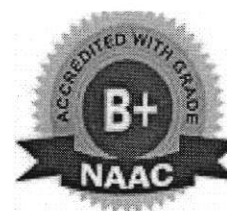


**CHAMAN LAL MAHAVIDHYALAYA,
LANDHAURA, MANGLAUR ROAD,
HARIDWAR (AUTONOMOUS)**



Affiliated
to

SRI DEV SUMAN UTTARAKHAND UNIVERSITY, BADSHAHITHAUL, TEHRI GARHWAL, UTTARAKHAND



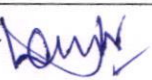
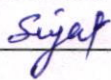
**NATIONAL EDUCATION POLICY-2020
STRUCTURE OF
PG -PHYSICS SYLLABUS
2025-2026**

**CHAMAN LAL MAHAVIDHYALAYA, LANDHAURA,
MANGLAUR ROAD, HARIDWAR (AUTONOMOUS)**

Affiliated to

SRI DEV SUMAN UTTARAKHAND UNIVERSITY, BADSHAHITHAUL, TEHRI GARHWAL, UTTARAKHAND

List of Members of Board of Studies

SI. No.	Name of the Members	Designation	Nominated as
1.	Mr. Vipul Singh	Assistant Professor	Chairman 
1.	Dr. Pawan Kumar	Associate Professor	External Expert 
2.	Dr. Vipin Kumar	Associate Professor	Principal Nominee
4.	Dr. Arvind Kumar	Assistant Professor	Member
5.	Mr. Sujat Hussain	Ex-Student	Nominated by Principal 

Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
Bachelor (Research in Physics)					
FOURTH YEAR	VII		Mathematical Physics	Theory	(04)
			Classical Mechanics	Theory	(04)
			Quantum Mechanics	Theory	(04)
			Communication Electronics	Theory	(04)
			Practical	Practical	(04)
	VIII		Atomic and Molecular Spectra	Theory	(04)
			Electrodynamics	Theory	(04)
			Astrophysics/ Elementary Particle Physics	Theory	(04)
			Condensed Matter Physics	Theory	(04)
			Elective Paper [one from the list] EL3**	Theory	(04)
			Practical	Practical	(04)
Master in Physics					
FIFTH YEAR	IX		Advanced Quantum Mechanics	Theory	(04)
			Computational Physics/ Plasma Physics	Theory	(04)
			Advanced Electronics -I/Astrophysics -I/High Energy Physics-I/ Spectroscopy-I/ Condensed Matter Physics-I	Theory	(04)
			Advanced Electronics -II/Astrophysics -II/High Energy Physics-II/ Spectroscopy-II/ Condensed Matter Physics-II	Theory	(04)
			Practical	Practical	(04)
	X		Nuclear Physics	Theory	(04)
			Digital Electronics and Computer Architecture	Theory	(04)
			Advanced Electronics -III/Astrophysics -III/High Energy Physics-III/ Spectroscopy-III/ Condensed Matter Physics-III	Theory	(04)
			Advanced Electronics -IV/Astrophysics -IV/High Energy Physics-IV/ Spectroscopy-IV/ Condensed Matter Physics-IV	Theory	(04)
			Practical	Practical	(02)

****Elective (04 Credit, one from the list EL3) To be opted in Semester VIII**

1. Statistical Physics
2. Bio Physics
3. Medical Physics
4. Atmospheric Physics
5. Nano Materials and Applications

Subject prerequisites:
Bachelor In Science with Physics as major subject.

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Amir

Sujat

Programme Outcomes (POs):

Students having Degree in **Bachelor (Research in Physics)** should have knowledge of advanced concepts of Physics and ability to apply this knowledge in various fields of academics, research and industry. They may pursue their future career in the field of academics, research and industry.

PO1	Competence in the methods and techniques of calculations using Mathematical Physics, Classical Mechanics, Quantum Mechanics and Communication Electronics. It will develop an analytical skill on an advanced level and will enable the student to have mathematical tools to solve complex problems of Physics. The Programme will motivate the student to know more about the matter, the universe and the recent developments in the field of science. The student will have adequate knowledge to work for the industry, consultancy, education, and research
PO2	The students would gain substantial knowledge in various branches of physics. The programme will enable the student to explore more in the field of his/her choice like Advanced Electronics, Spectroscopy, Astrophysics and High energy Physics. The student will be well equipped with the knowledge required for different organizations, industry, R& D sector.

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Programme specific outcomes (PSOs):

PG IST YEAR/ Bachelor (Research in Physics)

Bachelor (Research in Physics) programme provides the student the adequate knowledge, general competence, and analytical skills on an advanced level, needed in industry, consultancy, education, research, or in government organisation.

Programme specific outcomes (PSOs):

PG IIND YEAR/ Master in Physics

- ☐ The Master of Science in Physics programme provides student the adequate knowledge to use mathematical tools to solve complex physical problems and have the solid background and experience needed to analyze and solve advanced problems in physics.
- ☐ This course would enable the student to acquire scientific skills and the practical knowledge by performing experiments in general physics and electronics.
- ☐ The student would also get some research oriented experience by doing theoretical and experimental projects in the last semester under the supervision of faculty.



- The course as a whole opens up several career doors for the students interested in various areas of science and technology in private, public and government sectors. Students may get job opportunities in higher education, research organizations, physics consultancy and many others. Some of the institutions where physics students can start their career are: BARC, DRDO, NPTC, IISc, ISRO, ONGC, BHEL, PRL, NPL, SINP, VECC, IITs, NITs, IIPR etc.

Year wise Structure of PG in Physics (Core and Elective Courses)

	Subject: Physics											
Course/Entry-Exit Levels	Year	Sem	Paper I	Credit/hrs	Paper II	Credit/hrs	Paper III	Credit/hrs	Paper IV	Credit/hrs	Paper V	Credit/hrs
Bachelor (Research in Physics)	IV	VII	Mathematical Physics	4/60	Classical Mechanics	4/60	Quantum Mechanics	4/60	Communication Electronics	4/60		
		VII I	Atomic and Molecular Spectra	4/60	Electrodynamics	4/60	Elementary Particle Physics	4/60	Condensed Matter Physics	4/60	Elective Paper [one from the list] EL3**	4/60
Master in Physics	V	IX	Advanced Quantum Mechanics	4/60	Plasma Physics	4/60	Advanced Electronics - I/Astrophysics -I/High Energy Physics-I/ Spectroscopy-I		Advanced Electronics - II/Astrophysics -II/High Energy Physics-II/ Spectroscopy -II	4/60		
		X	Nuclear Physics	4/60	Digital Electronics and Computer Architecture	4/60	Advanced Electronics - III/Astrophysics -III/High Energy Physics-III/ Spectroscopy-III		Advanced Electronics - IV/Astrophysics -IV/High Energy Physics-IV/ Spectroscopy -IV	4/60		
Comments												
	Internal Assessment and External Assessment											
	Internal Assessments				Mark	External Assessment					Marks	

**DETAILED SYLLABUS FOR BACHELOR (RESEARCH IN
PHYSICS)
OR
P.G FIRST YEAR**

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VII/PAPER I
Subject: Physics		
Course code	Course Title: Mathematical Physics	
Course Outcomes		
Students would be able to understand the mathematical methods essential for solving the advanced problems in physics. It would be helpful in the development of the ability to apply the mathematical concepts and techniques to solve the problems in theoretical and experimental physics. The knowledge of mathematical physics would be beneficial in further research and development as it serves as a tool in almost every branch of science and engineering Course.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Special Functions Series solution of differential equations, Legendre, Bessel, Hermite, and Laguerre differential equation and related polynomial, physical integral form of polynomials and their orthogonality relations. Generating Function and recurrence relation.	15
UNIT II	Curvilinear Coordinates and Tensors Curvilinear Coordinates and various operators in circular, cylindrical and spherical coordinate systems, classification of Tensors, Rank of a Tensor, covariant and contra-variant tensors, symmetric and anti-symmetric Tensors, Kronecker delta symbol. Contraction of Tensor, metric Tensor and Tensor densities, covariant differentiation and Geodesic equation (variational Method).	15
UNIT III	Complex Variables Function of complex variable, Cauchy's Riemann differential equation, Cauchy's integral theorem, residues and Cauchy's residues theorem, singularities, evolution of residues and definite integral.	15

UNIT IV	Integral Transforms Fourier integral and Fourier Transform, Fourier integral theorem, finite and infinite integral, Laplace transform of elementary function (Dirac delta & Green's function), Solution of simple differential equations.	15
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Suggested Readings: B. S. Rajput: Mathematical Physics (Pragati Prakashan, Meerut) L. I. Pipes: Mathematical Physics (McGraw Hill) P. K. Chattopadhyay: Mathematical Physics (Wiley Eastern, New Delhi) Arfken.: Mathematical methods for Physics Harper Charlie: Introduction to Mathematical Physics Mathews and Walker: Mathematical Methods of Physics (Benjamin press) Horse and Feshbach : Methods of Theoretical Physics (McGraw Hill)		
Can be opted by		
Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites		
Bachelor in Science with Physics as major subject		
Suggested Equivalent Online Courses:		
1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3 . SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VII/PAPER II
Subject: Physics		
Course code	Course Title: Classical Mechanics	





Course Outcomes: In this course students would learn to apply the Newtonian laws using various mathematical formulations to describe the motions of macroscopic objects using generalized coordinates, momentum, forces and energy. The classical mechanics would be helpful in understanding of advanced branches of modern physics.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Mechanics of a System of Particles Constraints and generalized coordinates, D Alembert's principle, Lagrange equations for holonomic and non holonomic systems and their applications, conservation laws of linear momentum, energy and angular momentum.	15
UNIT II	Hamiltonian Formulation and Hamilton Jacobi Theory Hamiltonian equations of motion and their physical significance, Hamilton's principle, principle of least action, canonical transformations Hamilton-Jacobi theory, Poisson brackets, properties of Poisson bracket, Poisson's Theorem, Lagrange bracket.	15
UNIT III	Dynamics of a Rigid Bodies Motion of a rigid body, body and space Reference system, angular momentum and Inertia tensor, Principle axes- Principle moments of Inertia, spinning tops, Euler angles, Infinitesimal rotations.	15
UNIT IV	Central Force Problem Action and angle variables, phase integral, small oscillations, Kepler's laws of Planetary motion and their deduction, scattering in a Central field, Rutherford scattering cross section	15
Suggested Readings: H. Goldstein: Classical Mechanics N.C. Rana & P. S. Jog: Classical Mechanics Landau and Lifshitz: Mechanics, Pergamon Sommerfeld : Mechanics, Academic Press		

Whittaker: Analytical Dynamics of Particles and Rigid Bodies - Cambridge Raychaudhuri: Classical Mechanics, Oxford Bhatia: Classical Mechanics, Narosa. H.M. Agrawal: Classical Mechanics, New Age International	
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Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Bachelor in Science with Physics as major subject	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	





BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTE R VII/PAPER III
Subject: Physics		
Course code.....	Course Title: Quantum Mechanics	
Course Outcomes:		
The course provides an understanding of the behaviour of the systems at microscopic (atomic and nuclear) scale and even smaller. Students would learn basic postulates and formulations of quantum Mechanics. The course, in fact, plays an important role in explaining the behaviour of all physical systems in the universe. The course includes the study of a brief review of foundations of quantum mechanics, matrix formulation of quantum mechanics, symmetry in quantum mechanics and approximation methods for bound states.		
Credits: 4	Core Compulsory	
Max. Marks: 100 External Exam: 75 Internal assessment: 25	Min. Passing Marks: 36	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Non-Relativistic Quantum Mechanics and Schrödinger Equation Schrödinger's equation, Probability and current densities, continuity equation, physical interpretation of wave function, orthogonality of eigen functions, Principle of superposition, wave packet, normalization, Schrödinger's equation in three dimensions, centrally symmetric square well and harmonic potentials, harmonic oscillator and its wave functions, Hydrogen atom.	15
UNIT II	Operator Formulation of Quantum Mechanics State vectors and operators in Hilbert Space, Eigen values and Eigen vectors of an operator, Hermitian, Unitary and Projection operators, commuting operators, BRA and KET Notations, Postulates of Quantum Mechanics, co-ordinate Momentum and Energy representations, dynamical behavior, Heisenberg, Schrödinger and interaction Pictures	15
UNIT III	Theory of Angular Momentum Orbital Angular momentum operator, its eigen value and eigen functions, space quantization, spin angular momentum, Pauli's theory of spin, Addition of angular momentum, ClebschGordan coefficients	15
UNIT IV	Approximation Methods Time independent and Time dependent Perturbation Theory Stationary Perturbation, first and second order	15

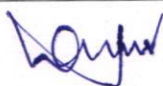
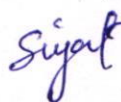
	corrections, WKB approximation methods, connection formula and boundary conditions, Bohr Sommerfield quantization rule, Penetration of potential barrier, Time independent perturbation theory and its applications. Applications of time-dependent perturbation theory for constant perturbation, Fermi Golden rule, Coulomb excitation, Sudden and adiabatic approximation.	
Suggested Readings B. S. Rajput: Advanced Quantum Mechanics Schiff: Quantum Mechanics Thankppan: Quantum Mechanics Loknathan and Ghatak Quantum Mechanics		
Can be opted by Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites Bachelor in Science with Physics as major subject		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VII/PAPER IV
Subject: Physics		
Course code.....	Course Title: Communication Electronics	
Course Outcomes		
This course helps the student to gain basic ideas of the fundamentals of communication systems. The course includes Modulation AM and FM (Transmission and reception), SSB transmission, AM detection, AGC, Radio receiver characteristics, FM transmitter, Propagation of Radio Waves ,Antenna , Fundamentals of image transmission,TV transmitter,Transmission Lines etc.The course may provide the opportunity to work in any organization related to communication.		
Credits: 4	Core Compulsory	
Max. Marks: 100 External Exam: 75	Min. Passing	

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Internal assessment: 25		Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Semiconductor devices: Diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices, device structure, device characteristics, frequency dependence and applications, optoelectronic devices (solar cells, photo-diode, LEDs, optocoupler).	15
UNIT II	Combinational Circuits: Boolean algebra, canonical forms of Boolean functions, simplification of Boolean functions (K-map method, tabulation method), don't care conditions. adders & subtractors, encoders, decoders, multiplexers, demultiplexers, digital to analog and analog to digital converters.	15
UNIT III	Sequential Circuits: Memory element: RS (using NAND and NOR Gate), clocked RS, JK, JKMS, D-type, T-type and edge triggered flip flop; Registers: right, left and left-right both type shift registers; Counters: asynchronous & synchronous counters, binary & non binary counters (use of K- maps), shift counter (Johnson counter), ring counter.	15
UNIT IV	Power Electronics: Characteristics and applications of Silicon controlled rectifier, TRIAC, DIAC & UJT	15

Suggested Readings: 1. Electronic Principles'- A.P. Malvino, TMH Publishing Company Limited. 2. 'Digital Fundamentals'- T.L. Floyd, Universal Book Stall, New Delhi. 3. 'Digital Principles and Applications'- A.P. Malvino and D.P. Leach, TMH Publishing Company Limited. 4. 'Digital Design'- M. Mano, PHI Private Limited.	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Bachelor in Science with Physics as major subject	

Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	
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BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)		YEAR IV
		SEMESTER VII/PAPER V
Subject: Physics		
Course code	Course Title: PRACTICAL	
Course Outcomes:		
Student would gain practical knowledge by performing various experiments of Electronics and Optics.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	List of Experiments	No. of Lectures

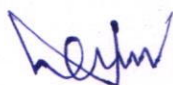
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	Study of RC circuit with an AC source using phase diagrams. Absorption Spectrum of KMnO₄ using Hilger-Nutting Photometer. Young's modulus by Interference method. NPN and PNP Transistor Characteristics with (a) Common base (b) Common emitter configurations/ h – parameter. Study of RC- coupled/ Transformer Coupled Amplifier. Study of B-H curve. Study of Amplitude Modulation /Demodulation. Verification of the Hartmann's Formula. Frank-Hertz experiment. e/m by Zeeman effect. Determination of susceptibility. Study of CRO. Velocity of Ultrasonic waves. Linear Air track. Lecher Wire	60
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Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites	
Bachelor in Science with Physics as major subject	
Suggested Equivalent Online Courses: - Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74 - Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities	



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BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER I
Subject: Physics		
Course code.....	Course Title: Atomic and Molecular Spectra	
Course Outcomes		
The course structure includes atomic and molecular spectroscopy. As per the course structure, the students learn basics concepts of spectroscopic principles and rules. Students would learn technique in spectroscopy and know about their applications. The course is helpful for the students to explore R & D opportunities in various areas of science and technology such as biomedical, industrial and environmental fields.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Fine structure of hydrogen spectrum, L-S and J-J coupling, Spectroscopic terms, Hund's rule and time reversal, Pauli's exclusion principle.	15
UNIT II	Alkali spectra, spin-orbit interaction and fine structure in alkali Spectra, Equivalent and non-equivalent electrons, Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Hyperfine structure (qualitative).	15
UNIT III	Molecular spectra of diatomic molecules, Born Oppenheimer approximation, elementary idea of quantization of rotational and vibrational energy, rotational spectra for rigid and non rigid rotations, vibrational spectra (harmonic and an-harmonic), intensity and selection rules and molecular constants.	15
UNIT IV	Atomic Polarizability, Raman spectra, Quantum theory of Raman spectra, Determination of molecular structure, Electronic spectra, band system, Progression and sequences, band head formation, Condon parabola, Franck Condon Principle dissociation energy and its determination	15
Suggested Readings: C. B. Banwell: Fundamentals of Molecular Spectroscopy Walker and Stranghen: Spectroscopy Vol. I, II, & III G.M. Barrow: Introduction to Molecular Spectroscopy Herzberg: Spectra of diatomic molecules		



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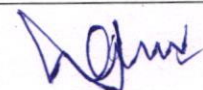
Walter

Jeanne L Mchale: Molecular Spectroscopy J. M. Brown: Molecular Spectroscopy P. F. Bemath: Spectra of atoms and molecules J. M. Holias: Modern Spectroscopy K. Thyagrajan and A.K. Ghatak: Lasers: Theory and applications A Yariv: Quantum Electronics M. D. Levenson: Intoduction to non-linear laser spectroscopy B. B. Laud: Laser and non-linear optics	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VII with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER II
Subject: Physics		
Course code.....	Course Title: Electrodynamics	
Course Outcomes: The study of electrodynamics provides basic foundation for the student to understand advance courses of physics. The course includes Basic equations of Electromagnetism; Electrostatics; Magnetostatics; Maxwell's equation, Four Vector Formalism of Maxwell's Equations Four vector potential, electromagnetic field tensor and Quantization of electromagnetic energy		
Credits: 4	Core Compulsory	
Max. Marks: 100 External Exam: 75 Internal assessment: 25	Min. Passing Marks: 36	

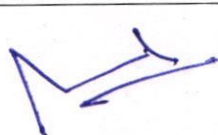
 Subject 

Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Electromagnetism Basic equations; Electrostatics; Magnetostatics; Different Systems of Units, Preliminary notations, four- vectors, Lorentz transformations, time, space and light like separations, Lorentz invariants, Energy and Momentum.	15
UNIT II	Maxwell's Equations Maxwell's equation, Displacement current, electromagnetic waves in conducting and nonconducting medium, Poynting theorem, boundary condition at the interface of conducting and non conducting media, propagation between parallel conducting plates. Electromagnetic wave equations	15
UNIT III	Four Vector Formalism of Maxwell's Equations Four vector potential, electromagnetic field tensor, Lorentz invariance, Lorentz force, covariant form of Maxwell's equations, four vector current, continuity equation, Gauge invariance of Maxwell equation, electromagnetic energy-momentum tensor, Motion of charge particle in electromagnetic field, Lorentz force	15
UNIT IV	Electromagnetic Radiation Lienard-Witchert potential, conventional potential, Quantization of electromagnetic energy (virtual photon), Radiation from an Accelerated Charge, Fields of an accelerated charge; angular and frequency distributions of the emitted radiation, special cases of acceleration parallel and perpendicular (circular orbit) to velocity; Larmor's	15
	formula and its relativistic Generalization; Bremsstrahlung, Cerenkov radiation	
Suggested Readings Jackson: Classical electrodynamics; Wiley Eastern, New Delhi Landau and Lifshitz: Classical theory of fields; Pergameon Press Thide: Electromagnetic field Theory Panofsky and Phillips: Classical Electricity and Magnetism Landau & Lifshitz: Electrodynamics of Continuous Media		
Can be opted by Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		


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Course Prerequisites Passed Semester VII with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

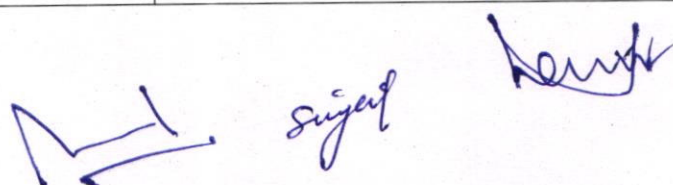
BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER III a
Subject: Physics		
Course code	Course Title: Astrophysics	
Course Outcomes		
The course is important for the students to learn about the most fundamental building blocks of Universe and Solar system and hence to understand Stellar system. The course provides a platform for the students seeking research opportunities in Astrophysics.		
Credits: 4	Core Compulsory	



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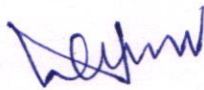
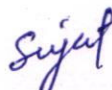
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Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	The universe and Solar System: Basic idea of universe and galaxies, Astronomical telescopes. The solar system. Classification of the Planets, Orbits, Laws of planetary motion. Physical features, surface features, Internal Structure. Atmosphere, Satellites and Rings. Asteroids, Meteors and Meteorites their types, Orbits: physical nature and composition. Origin of the minor planets, Observation of meteor showers and sporadic meteors Meteorite craters. Origin of Comets, Periodic comets, Physical nature, Spectra, Brightness variation. Gas production rates, dust and ion tails.	15
UNIT II	Stellar System: Sun as a Star: History of Sun, Sun's interior, the photosphere, the solar atmosphere (chromosphere & corona). Salient features of sunspots, sun's rotation & solar magnetic field, explanation for observed features of sunspots. Distances of stars from the trigonometric. Secular and moving cluster parallaxes. Stellar motions, Magnitude scale and magnitude systems. Atmospheric extinction. Absolute magnitudes and distance modulus. color index. The Hertzsberg- Russell Diagram: The colour, Brightness or luminosity, the population of star. Elementary idea of Binary & Variable Stars. Nuclear fission, Nuclear fusion, condition for nuclear reaction in stars. Types of galaxies, Structure and features of the Milky Way Galaxy	15
UNIT III	Physics of the Stars: Apparent and Mean Position of stars. Effects of atmospheric refraction, aberration. parallax, precession, nutation and proper motion on the coordinates of stars. Reduction from apparent to mean places and vice versa. Spectra of Stars. Distribution of stars in space. Statistical parallaxes. Local standard of rest. Solar motion and its determination. Peculiar velocities. Single and Twostar stream hypothesis. Velocity ellipsoid. Comparison with solar neighbourhood. Bottlinger's diagram. HR diagram. HD and MK spectral classification of stellar spectra. Radiation laws and basic ideas on spectral line formation. Explanation of stellar spectra in terms of Boltzmann and Saha equations. Spectroscopic parallax	15



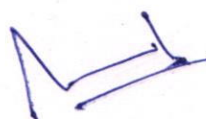
UNIT IV	Fundamental Equations: Equation of mass distribution. Equation of hydrostatic equilibrium. Equation of energy transport by radiative and convective processes. Equation of thermal equilibrium. Equation of state. Stellar opacity. Stellar energy sources. Stellar models: The overall problem and boundary conditions. Russell- Voigt theorem. Dimensional discussions of mass-luminosity law. Polytropic configurations. Homology transformations.	15
	Suggested Readings: 1. Principles of Stellar Dynamics, S. Chandrasekhar 2. The Great Universe, G K Sudarshan, S chand Publications. 3. Our Solar System, Joshi and Rana, New Age Publications 4. Galaxies and Universe, K.C. Freeman: 5 The Origin and Evolution of Galaxies, S.D. M. White: 6. Lecture notes on "Dynamics of Stellar Systems", S. M. Alladin: 7. Stars and Galaxies: K. D. Abhyankar (Tata McGraw Hill Publication) 8. Exploration of the Universe: G. Abell 9. The Structure of Universe: Jayant Naralika 10. Physics of Comets: K.S. Krishnaswamy	

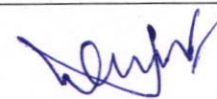
11. Our solar system: A.W. Joshi & N. Rana 12. Introduction to Astrophysics: Baidyanath Basu 13. Astrophysics of the Sun: Harold Zirin 14. The Quiet Sun: Gibson 15. Stellar Evolution: M. Schwarzschild 16. S. Chandrasekhar: Stellar Structure: S. Chandrasekhar 17. Principles of Stellar Interiors - Vol.I and II: Cox and Guili 18. White Dwarfs, Neutron Stars and Black Holes: Shapiro andTevkolsky.	
Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VII with Physics as major	

Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	
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BACHELOR (RESEARCH IN PHYSICS)				
Programme: BACHELOR (RESEARCH IN PHYSICS)		YEAR IV	SEMESTER VIII/PAPER III b	
Subject: Physics				
Course code		Course Title: Elementary Particle Physics		
Course Outcomes				
The course is important for the students to learn about the most fundamental building blocks of matter and radiation, interaction among elementary particles and hence to understand their behaviour. The course provides a platform for the students seeking research opportunities in high energy physics.				
Credits: 4			Core Compulsory	
Max. Marks: 100 External Exam: 75 Internal assessment: 25			Min. Passing Marks: 36	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0				
UNIT		TOPIC		No. of Lectures
UNIT I		Elementary Particles History of elementary particles, Classification of elementary particles, Fundamental interactions, Resonances, Lepton and Baryon number; Isospin, Strangeness, Hypercharge, Gell - Mann Nishijima relations, Symmetries and conservation laws, Parity, Time reversal and charge conjugation, Parity violation, CP violation in mesons, CPT invariance.		15
UNIT II		Unitary Symmetries and Application in the Physics of Elementary Particles Basics of unitary groups, fundamental representation of SU(2), SU(3) diagonal generators and weights, generators of SU(2) and U(2), weight diagram of fundamental representation of SU(2), generators of SU(3) and U(3), Weight of first fundamental representation of SU(3), shift operators, I, U, V spins, complete weight diagram for the (1 0), (0 1), (3, 0), (1 1) and (2 1) representations of SU(3) , Gell Mann Okubo Mass formula.		15





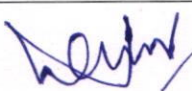
UNIT III	Method of Young Tableaux and its Applications Young Tableaux and unitary symmetry, standard arrangements of young tableaux, Dimensionality of the representations of $SU(N)$, Multiplets of $SU(N-1)$, subgroup of $SU(N)$, Baryon multiplets in different representations, general rule and its application for reducing kronecker product of two representations, kronecker product of three particle state vectors.	15
UNIT IV	Nuclear and Particle Detectors Basic principle of particle	15

	detectors, Ionization chamber, Proportional counter, Geiger-Muller Counter, Scintillation counters and-ray spectrometer, semiconductor detector, Nuclear emulsion technique, Cloud chamber, Bubble chamber	
Suggested Readings: D. H. Perkins: Introduction to High Energy Physics, Cambridge University Press, 2000 S. N. Ghoshal: Atomic and Nuclear Physics, S. Chand and Company Ltd, 1994 D. Griffiths: Introduction of Elementary Particles DB Lichtenberg: Unitary Symmetry and Elementary Particles, Academic Press, 1978 Hughes: Elementary Particles Blatt and Weiskopf: Theoretical Nuclear Physics FE Close: Quarks and Patrons P. P. Cheng and G. LF Li: Gauge Field Theory: W. E. Burcham: Nuclear Physics R. M. Singru: Introduction to experimental nuclear physics E. Segre: Experimental nuclear physics		
Can be opted by Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites Passed Semester VII with Physics as major		

Suggested Equivalent Online Courses: 4. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 5. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/npTELhrd6.SwayamPrabha-DTHChannel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	
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BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER IV
Subject: Physics		
Course code	Course Title: Condensed Matter Physics	
Course Outcomes:		
The students will be able to develop an understanding of the lattice, different types of crystal structures, symmetries. The student would gain insight about the interior of the substances using X-ray diffraction in crystals. This course also includes elastic waves, phonons, and lattice vibrational properties and also superconductivity. The course forms a theoretical basis of experimental material science and technology.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Symmetry and Reciprocal Lattice: Crystal symmetry elements, Miller indices, Direct lattice type, fundamental type of direct lattices i.e. 2 dimensional and 3 dimensional lattice, Diffraction of Waves by Crystal: The Bragg law, Fourier Analysis, Reciprocal lattice Vectors, Diffraction Condition. Brillouin Zones, Reciprocal lattice (example of sc, bcc, fcc, hcp lattices), Crystal structure factor (bcc, fcc), Atomic form factor, Scattering factors, Intensity of diffraction maxima, extinction due to lattice centering.	15
UNIT II	Lattice Vibrations: Concept of dispersion relation, quantization of lattice vibrations (Phonons), normal modes & normal coordinates, longitudinal and transverse modes of vibration, modes of vibration of monatomic and diatomic lattices. Density of states (Phonons).	15

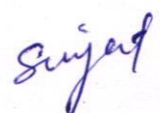




UNIT III	Free Electron theory of metals: Free electron theory of metals, free electron gas in one dimensional box, free electron gas in three dimensional box-filling up of energy bands, Density of electron states, Fermi energy, Average kinetic energy of electron , average velocity.	15
UNIT IV	Thermal properties of solids: Specific heat of solids, Classical theory, Einstein theory, The Debye theory, Born's modification of the Debye theory. Heat capacity of diatomic lattices. Thermal conductivity. Lattice thermal conductivity. Phonon mean free path. Phonon-phonon scattering-the umklapp processes. Thermal Expansion. Origin of thermal expansion. Gruneisen relation	15

Suggested Readings A.J. Dekker: Solid State Physics Ashcroft and Mermin: Solid State Physics S.O. Pillai: Solid State Physics R. L. Singhal: Solid State Physics C. Kittel: Introduction to Solid State Physics Verma &Srivastava: Crystallography for Solid State Physics	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VII with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha-DTHChannel , https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII/PAPER V
Subject: Physics		
Course code	Course Title: PRACTICAL	


Course Outcomes: The student will have adequate knowledge to perform the experiments of different fields of physics with clear understanding of the theory behind the experiment. Student will know about various electronic components and learn to design some basic electronic circuits and study their applications.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4		
UNIT	List of Experiments	No. of Lectures
	1. Study of the Phase measurement by superposition of voltages with LCR Circuits. 2. Study of different oscillators (Hartely, colpitt, Weinbridge oscillators etc.). 3. Study of an electronically regulated power supply. 4. Study of negative Feed- back Amplifier. 5. Determination of wavelength (λ) and wavelength difference ($\Delta\lambda$) by Michelson Interferometer. 6. Study of different type of Resistances and Diodes. 7. Study of Photo Voltaic Cell. 8. Stefan's Constant 9. FET characteristics 10. Fresnel's Law 11. Cauchy Formula 12. Lattice Dynamic Kit 13. Study of Logic gates 14. Detection Efficiency of Diode 15. Fabry – Perot Interferometer 16. Four Probe method	60
Can be opted by Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites Bachelor in Science with Physics as major subject		
Suggested Equivalent Online Courses: 1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74 2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities		

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII EL3(1)
Subject: Physics		
Course code	Course Title: Statistical Physics	

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Course Outcomes:		
The course structure includes different aspects of statistical Mechanics and Statistical models for phase transition. Study of this course will enable students a clear understanding of classical and Quantum Statistics.		
Credits: 4		Elective
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 33
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Foundation of Statistical Mechanics Microscopic and macroscopic states, Density of states, Micro-canonical, Canonical and grand canonical ensembles, Canonical ensemble and Gibb's distribution, Boltzmann-Planck method, Partition function and statistical definition of thermodynamic quantities, Computation of partition functions of some standard systems.	15
UNIT II	Statistical Properties System of linear harmonic oscillators in the canonical ensemble; Grand canonical ensemble and its partition function; Chemical potential; Partition function and distribution for perfect gas; Gibb's paradox; Free energy, entropy, Equation of state and specific heat determination of perfect gas.	15
UNIT III	Statistical models Theory of phase transitions, First order phase transition, Second order phase transitions and higher order phase transitions (elementary discussion), Ising model, One dimensional (with exact solution), Two dimensional (with exact solution) & three dimensional model (elementary idea), Landau theory of phase transition, Weiss theory of Ferro-magnetism, Heisenberg model. Virial equation of states.	15
UNIT IV	Quantum Statistics Bose-Einstein and Fermi- Dirac distributions, Degeneracy, Gas degeneration, Degenerate Bose gas, Bose Einstein condensation, Highly degenerate B-E and F- D gases; examples of Molecular Hydrogen, liquid helium and electron gas in metals.	15
Suggested Readings Quantum Mechanics: A. S. Davidov Quantum Mechanics: B. S. Rajput Quantum Mechanics: Paul Roman Theoretical Chemistry: Glastohn Statistical Mechanics: Landau and Lifshitz Statistical Mechanics: Pathira Statistical Mechanics: Huang		
Can be opted by Bachelor in Science with Physics as major subject		

Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VII with Physics as major	

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,
<https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning
(NPTEL), <https://www.youtube.com/user/nptelhrd3>. SwayamPrabha -
DTH Channel,
https://www.swayamprabha.gov.in/index.php/program/current_he/8


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BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII EL3(2)
Subject: Physics		
Course code	Course Title: Bio Physics	
Course Outcomes:		
Biophysics is the field that applies the theories and methods of physics to understand how biological systems work. The student's knowledge can be used in the sector related to health and Medical .		
Credits: 4		Elective
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Basic Concepts in Biophysics Elementary ideas about the DNA structure, Forces stabilizing DNA and protein structure, sugar-phosphate backbone, nucleosides and nucleotides, three dimensional DNA structure, RNA. Proteins: primary, secondary, tertiary and quaternary structures, enzymes and their catalytic activity, DNA and protein folding, DNA denaturation, replication, mutation, intercalation, neurotransmitters, membranes.	15
UNIT II	Technique for The Study of Biological Structure and Function Application of experimental techniques of light scattering (tomography), FTIR and Raman spectroscopy, absorption and fluorescence spectroscopy/ microscopy, anisotropy, optical activity, circular dichroism, electrophoresis,.	15
UNIT III	Photobiology interaction of light with cell and tissues, Photosynthesis, human eye and vision optical biopsy, optical biosensors, Laser tweezers and Laser Scissors Photo-dimerization, Photodynamic therapy.	
UNIT IV	Radiation Effects on Biological Systems High doses received in a short time, Low-level doses limits, direct ionization of DNA, radiation damage to DNA, Biological effects (Genetic, Somatic, Cancer and sterility). Bio-imaging: Ultrasound, MRI imaging, confocal fluorescence imaging and X-ray.	15
Suggested Readings:		
Essentials of Biophysics: P. Narayanan. Basic Molecular Biology: Price.		

Quantum Mechanics of Molecular Conformations: Pullman (Ed.). Non-linear Physics of DNA: Yakushevich. Biological Physics: Nelson. Spectroscopy of biological systems Modern Spectroscopy: J.M. Hollas. Transmission Electron Microscopy of Metals: Gareth Thomas Elements of X-ray Diffraction: Bernard Dennis Cullity.	
Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VII with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII EL3(3)
Subject: Physics		
Course code	Course Title: Medical Physics	
Course Outcomes:		
Medical Physics is a branch of science that uses the methods of physics to study biological processes and also working of the instruments and machines used in Medical Science .Physics uses mathematical laws to explain the natural world, and it can be applied to biological organisms and systems to gain insight into their workings. The course includes Physics of Respiratory and Cardiovascular System, Electricity in the Body and Sound/Light and also Equipment's and Modern Medicines .The course opens future prospects of the student in the field of Medical Science .		
Credits: 4	Elective	
Max. Marks: 100 External Exam: 75 Internal assessment: 25	Min. Passing Marks: 36	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures

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UNIT I	Mechanics of Human Body Static, Dynamic and Frictional forces in the Body, Composition, properties and functions of Bone, Heat and Temperature, Temperature scales, Clinical thermometer, Thermography, Heat therapy, Cryogenics in medicine, Heat losses from Body, Pressure in the Body, Pressure in skull, Eye and Urinary Bladder.	15
UNIT II	Physics of Respiratory and Cardiovascular System Body as a machine, Airways, Blood and Lungs interactions, Measurement of Lung volume, Structure and Physics of Alveoli, breathing mechanism, Airway resistance, Components and functions of Cardiovascular systems, work done by Heart, Components and flow of Blood, Laminar and Turbulent flow, blood Pressure, direct and indirect method of measuring, Heart sounds.	15
UNIT III	Electricity in the Body and Sound/Light In Medicine Nervous system and Neuron, Electrical potentials of Nerves, Electric signals from Muscles, Eye and Heart, Block diagram and working to record EMG, Normal ECG wave form, Electrodes for ECG, Amplifier and Recording device, Block diagram and working to record ECG, Patient monitoring, Pace maker. General properties of sound, Stethoscope, Generation, detection and characteristics of Ultrasound, Ultrasound imaging technique, A scan and B scan methods of ultrasound imaging,	15

	properties of light, Applications of visible UV, IR light, and Lasers in medicine, Microscope, Eye as an optical system, Elements of the Eye, Ophthalmology Instruments.	
UNIT IV	Diagnostic X-Rays and Nuclear Medicine Production and properties of X-rays, Basic Diagnostic X-ray Machine, X-ray image, Live X-ray image, X-ray computed Tomography, Characteristics of Radio activity, Radioisotopes and Radio nuclides, Radioactivity sources for Nuclear medicine, Basic Instrumentation and clinical applications, Principles of Radiation Therapy, Nuclear medicine imaging devices, Radiation sources.	15
Suggested Readings: Medical Physics by Department of Physics, St. Joseph's College, Trichy-2. Medical Physics by John R. Cameron and James G. Skofronick, John Wiley & Sons. Hand book of Biomedical Instrumentation : R.S.Khandpur, Tata McGraw Hill Publication Co., Delhi, 1987.		
Can be opted by Bachelor in Science with Physics as major subject		

Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VII with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel , https://www.swayamprabha.gov.in/index.php/program/current_he/8	

BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII L3(4)
Subject: Physics		
Course code	Course Title: Atmospheric Physics	
Course Outcomes: The course introduces students to Earth- Atmosphere and Meteorology The course includes Environmental pollution and climate change etc. The course is useful for the students who want to work in Metereological department or wants to pursue his/her career in the field of environmental science . The course is also very important for R& D purposes.		
Credits: 4		Elective
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 33
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Introduction to Earth Atmosphere and Meteorology Elementary concept of atmospheric sciences, atmosphere and it composition, Thermal and pressure variation in earth atmosphere, Thermal structure of the troposphere, stratosphere, mesosphere and ionosphere, Hydrostatic equation, spectral distribution of the solar radiation, Green house effect and effective temperature of earth. Meteorological process and different system, local winds, monsoons, fogs, clouds, precipitation, Cyclones and anti- cyclones, thunderstorms, Mountain Meteorology	15
UNIT II	Atmospheric Dynamics and Thermodynamics Introduction to atmospheric dynamics, Basic conservation laws, Applications of the basic equations, circulations and vorticity, Atmospheric oscillations, The general circulations, Tropical dynamics, Thermodynamical considerations, Adiabatic and isothermal processes, equation of state for dry and moist air, Humidity parameters, laws of thermodynamics, Entropy, Thermodynamic diagram and their uses.	15

UNIT III	Environmental pollution and climate change Atmospheric pollution, type of pollutants, various sources of emissions, Trace gases, Production and loss processes of stratosphere ozone, Tropospheric ozone, Role of trace gases and their budget, motion of air-masses (back-air trajectory), tools for modeling (Box model and 3-D model), Atmospheric aerosols, classification and properties, concentration and size distribution, Absorption and scattering of radiation, optical phenomena in atmospheric, Modeling for aerosols, Estimations of radiative forcing. Definition of climate long term changes, possible causes of climate change-External and internal, General idea of internal dynamical processes of the atmosphere, climate modeling, Review of various climate models.	15
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UNIT IV	Instrumentation and Observational Techniques Convectional measurements of pressure, temperature, humidity, wind speed and direction, sunshine duration, radiation clouds, upper air pressure, temperature, humidity and wind measurements, Polit balloons, radiosonde, dropsonde, ozonesonde, GPS sonde. Application of radars to study the atmospheric phenomenon, LIDAR, SONAR, RASS (Radio-acoustic sounding system), Observational technique for aerosol.	15
Suggested Readings: S. Pettersen: An Introduction to meteorology H. R. Byer: General Meteorology Miller, Thompson and Paterson: Elements of meteorology J. M. Wallau and P. V. Hobbs: Atmospheric Science J. A. Ratchiffe: Physics of upper atmosphere R. B. Stull: An introduction to boundary layer Meteorology D. H. Lenschow: Probing the atmospheric boundary D. H. Lechow: Intruments and Techniques for probing the atmospheric boundary layer A.A. Tsonis: An introduction to atmospheric Thermodynamics H. J. Critchfield: General Climatology G. T. Trewartha: An introduction to climate		
Can be opted by Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites Passed Semester VII with Physics as major		

Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	
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BACHELOR (RESEARCH IN PHYSICS)		
Programme: BACHELOR (RESEARCH IN PHYSICS)	YEAR IV	SEMESTER VIII L3(5)
Subject: Physics		
Course code	Course Title: Nano Materials and Applications	
Course Outcomes: This course introduces the essence of nano materials, their synthesis, and characterization. On successful completion of the module students should also be able to understand the optical properties and electron transport phenomenon in nanostructures. It also covers few important applications of nano materials used in this technological era.		
Credits: 4		Elective
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 33
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Nanoscale Systems Density of states (1-D,2-D,3-D). Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.	15
UNIT II	Synthesis of Nanostructure Materials Metals, Metal Oxide, Carbon based nanomaterials CNT, C60, graphene. Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, Chemical vapor deposition (CVD).Sol-Gel. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots. X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.	15

UNIT III	Optical Properties Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and	15
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	excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructures and nanostructures.	
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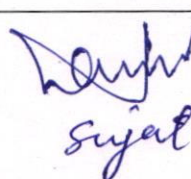
UNIT IV	Electron Transport and Applications of Nanoparticles Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity. Defects and impurities: Deep level and surface defects. Applications: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots -magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).	15
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Suggested Readings: C. P. Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.). S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company) K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited). Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Strosio, 2011, Cambridge University Press. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).		
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Can be opted by Bachelor in Science with Physics as major subject	
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Suggested Continuous Evaluation Methods:	
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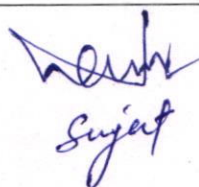
Course Prerequisites Passed Semester VII with Physics as major	
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Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	
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MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER I
Subject: Physics		
Course code	Course Title: Advanced Quantum Mechanics	
Course Outcomes:		
The course includes the study of scattering theory, identical particles, relativistic wave equations and quantization of wave fields. The course would describe the nature and behaviour of matter and energy at subatomic level. In particular, theory of scattering gives an understanding collision between a quantum mechanical particle and target. The study of relativistic quantum mechanics enables the students to understand the behaviour of objects moving with speeds comparable to that of light. The knowledge of this field forms the foundation for pursuing research in Quantum Field Theory and High Energy physics.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Free particle Dirac equation Discrepancies faced by Schrödinger equations, Klein-Gordon equation and its drawbacks, Dirac's equation for a free particle, Dirac matrices, covariant form of Dirac equation, Probability and current densities, Free particle solutions of Dirac equation, Non conservation of Orbital Angular momentum and idea of spin, Interpretation of negative energy and hole theory	15
UNIT II	Dirac particle in Electromagnetic Fields Dirac equation in electromagnetic fields, Magnetic moment of charged particle, Gauge invariance of Dirac equation in electromagnetic fields, Non- relativistic correspondence of Dirac equation; Pauli equation, Adjoint spinors, Symmetries of Dirac Equation: Parity, Time reversal and Charge Conjugation; Lorentz covariance of Dirac Equation, , Bilinear covariants	15

UNIT III	Identical Particles and Quantum Field Theory Identical particles, exchange degeneracy, symmetric and anti symmetric functions for many particle system Classical Fields, Schwinger's action principle, Lagrangian and Hamiltonian densities, Field equation, quantum structure of free fields and the particle concept,	15
	Quantization relations, Quantization of non relativistic Schrödinger matter field, System of identical bosons and fermions, Commutation and anti-commutation relations, Occupation number representation, creation and annihilation operators.	
UNIT IV	Quantum Theory of Scattering Scattering Theory, Scattering cross section, method of partial wave analysis, phase shift, Optical theorem, scattering length, effective range theory; low energy scattering, Resonance, scattering from a square potential well and a rigid sphere, Born approximation, Validity of Born approximation, Born approximation through time dependent perturbation, its application to square well potential.	15
Suggested Readings: Davydov: Quantum Theory Messiah : Quantum Mechanics Vols. I & II Rajput B. S.: Advanced Quantum Mechanics Ropman P.: Advanced Quantum Mechanics Trigg: Quantum Mechanics Thankappan V. K.: Quantum Mechanics Sakurai J.J.: Quantum Mechanics		
Can be opted by Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites Passed Semester VIII with Physics as major		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

MASTER IN PHYSICS			
Programme: MASTER IN PHYSICS		YEAR V	SEMESTER IX PAPER II a
Subject: Physics			
Course code		Course Title: Computational Physics	
Course Outcomes: The subject on Computational Physics has been framed to equip the students of M.Sc. Physics with knowledge of roots of equation, interpolation, curve fitting, numerical differentiation, numerical integration, solution of ordinary differential equations and probability.			
Credits: 4			Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25			Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	TOPIC	No. of Lectures	
UNIT I	Roots of Algebraic and Transcendental Equations: Element of computational techniques: roots of functions, Interpolation, Extrapolation, One point and two-point iterative methods such as bisection method and Newton Raphson methods.	12	
UNIT II	Integration and Differential: Integration by Trapezoidal and Simpson's rule, Solution of first order differential equation using Runge-Kutta methods, Finite difference methods. Data Interpretation and Error analysis: Dimensional analysis, Precision and accuracy, error analysis, Propagation and errors.	15	
UNIT III	Least square fitting: Least square fitting, Linear and nonlinear curve fitting, Chi square test. Random numbers: Introduction to random numbers, Monte Carlo method for random number generation. Probability Theory: Elementary probability theory, Random variables, Binomial, poisson and normal distributions, Central limit theorem.	15	

UNIT IV	Materials Modelling through VASP and SIESTA: Basis Sets: plane waves versus numerical atomic orbitals basis sets, Pseudopotentials: ultrasoft versus norm conserving pseudopotentials. Numerical solutions of KohnSham equations, Diagonalization procedure, SCF cycles and mixing scheme, Smearing: Gaussian, Fermi and Methfessel-Paxton smearing. SIESTA and VASP package to perform: electronic structure calculations, relaxation of atomic positions and unit cell parameters. Structural properties: equilibrium lattice constant, cohesive energy, bulk modulus.	18
Suggested Readings: 1. David S. Sholl and Janice A. Steckel, Density Functional Theory: A Practical Introduction (John Wiley and Sons, 2009). 2. Gunn Lee, Computational Materials Science: An Introduction, (CRC Press 2011) 3.		

3. C. Kittel, Introduction to Solid State Physics (Wiley India (P) Ltd., New Delhi, India) 2007	
Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VIII with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER II b
Subject: Physics		
Course code	Course Title: Plasma Physics	
Course Outcomes: The course includes Magneto Hydrodynamics, Plasma Propagation and other topics related to plasma. Plasma physicists study plasmas, which are considered a distinct state of matter and occur naturally in stars and interplanetary space .The knowledge acquired by the student can be used in various field of Physics and thus career prospects are bright in the field of research.		
Credits: 4	Core Compulsory	

Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Introduction to Plasma Elementary concept of plasma: Debye Shielding, Plasma parameters, Drift of guiding center, Gradient drift, Curvature drift, Magnetic mirror, Plasma confinement	15
UNIT II	Magneto-Hydrodynamics and Fluid Plasma Plasma Oscillation, Fluid equations for a plasma, Continuity equation, Wave Propagation in unmagnetized plasma, Magneto Hydrodynamics, Hydrodynamical description of Plasma: fundamental equation, Concept of convective derivative, hydromagnetic waves, magneto-sonic and Alfvén waves.	15
UNIT III	Magneto Plasma Wave phenomena in Magneto plasma: Polarization, Phase velocity, group velocity, cutoff, resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field Helicon, Faraday rotation,.	15
UNIT IV	Electromagnetic Wave Propagation in Plasma Propagation at finite angle and CMA diagram, Propagation through ionosphere and magnetosphere Derivation of moment Equation from Boltzmann Equation, Momentum balance equation, Equations of state, Two-fluid equations, Plasma resistivity	15
Suggested Readings: Jackson: Classical Electrodynamics; Wiley Eastern, New Delhi		

Bittencourt: Plasma Physics Chen: Plasma Physics Robert J Goldston and Paul H. Rutherford: Introduction to Plasma Physics	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VIII with Physics as major	



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Suggested Equivalent Online Courses:

4. MIT Open Learning - Massachusetts Institute of Technology,
<https://openlearning.mit.edu/>
5. National Programme on Technology Enhanced Learning
(NPTEL), [https://www.youtube.com/user/nptelhrd6.SwayamPrabha -
DTH Channel,](https://www.youtube.com/user/nptelhrd6.SwayamPrabha-DTHChannel)
https://www.swayamprabha.gov.in/index.php/program/current_he/8


Sujat

MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER III a (Specialization paper)
Subject: Physics		
Course code	Course Title: Advanced Electronics- I	
Course Outcomes: This course helps the students to gain basic ideas of the construction and working of electronic devices and circuits . The course includes the study of IC technology, Operational amplifier as linear Analog systems and non-linear analog systems. The course is of much practical purpose for the students to learn basics of integrated circuit technology which has wide applications in computing, process control, signal processing, communication systems, digital instruments etc.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Transmission Lines: Types of transmission lines, transmission line as a two conductor system, transit time effect, calculation of line parameters, voltage and current relation on radio frequency transmission line, propagation constant and its physical significance, line distortion and attenuation, characteristic impedance, reflection coefficient, loss less, distortion less and low loss transmission lines, line termination by (i) zero load or short circuit line, (ii) infinite impedance, (iii) some resistance, (iv) complex impedance, voltage standing wave ratio.	15
UNIT II	Propagation of Radio Waves: Ground wave, space wave and sky wave propagation (ionosphere & it's different regions, Eccles-Larmor theory, magneto ionic theory, Appleton-Hartree formula, skip distance and maximum usable frequency).	15
UNIT III	Amplitude Modulation & Demodulation and Receiver & Transmitters: Need for modulation, type of modulation, amplitude modulators (square law diode & collector modulation methods), amplitude demodulators (square law & envelope detectors), DSB-SC system (balanced modulator and synchronous detector), SSB-SC signal (frequency & phase discrimination method of modulation and demodulation), VSB signal (filter & phase discrimination method of modulation), AM receivers (TRF & superheterodyne, AGC), AM transmitter.	15
UNIT IV	Antenna : Radiation, flared transmission line, magnetic vector potential and electric scalar potentials, different electric and magnetic fields generated by Hertz dipole, near and far fields, power radiated by Hertz dipole, radiation pattern, Directivity, gain of the antenna, dipole antenna, HF antenna, Yagi antenna,	15

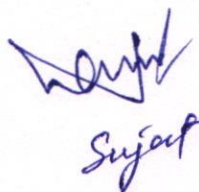
	loop antenna, reflector antennas.	
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Suggested Readings: Antennas and Wave Propagation', J.D. Kraus, R.J. Marhefka and A.S. Khan, TMH 'Communication Systems: Analog & Digital', R.P. Singh and S.D. Sapre, TMH Antenna & Wave Propagation', K.D. Prasad, Satya Prakashan, New Delhi. Mcgraw Hill Millman and Halkias: Electronic Fundamentals & Applications, Tata Mcgraw Hill Millman and Halkias: Integrated Electronics K.R. Botkar: Integrated Circuits, Khanna Publishers G.K. Mithal and Ravi Mittal: Electronic Devices & Circuits, Khanna Publishers Roychaudhary and Jain: Operational Amplifier & Linear Integrated Circuits V.K. Mehta: Electronics for Scientists & Engineers Robert J Goldston and Paul H. Rutherford: Introduction to Plasma Physics	
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Subject

Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VIII with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

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MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER III b (specialization paper)
Subject: Physics		
Course code	Course Title: Astrophysics –I	
Course Outcomes:		
The course would be important to understand the spherical astronomy, distance measurement in astrophysics, and physics of solar system and extra solar planets. The course provides an opportunity to understand the optics of the different astronomical instruments such as: telescopes, CCD camera etc. It has wide spread in use of R& D sector.		
Credits: 4	Core Compulsory	
Max. Marks: 100 External Exam: 75 Internal assessment: 25	Min. Passing Marks: 36	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Spherical Astronomy Celestial sphere, Celestial coordinate system (equatorial and alt-azimuth): altitude and azimuth, right ascension and declination, hour angle, sidereal time, mean solar time, summer and winter solstice, seasons. Distance measurements: AU, parsec, standard candles, distance measurement by geometric means (parallax, distances to open clusters).	15
UNIT II	Solar System Idea of solar system, Study of planets and their satellites, Earth-Moon system, tidal forces, asteroids, meteors, comets and their origin, composition and dynamical evolution, extra solar planets and their detection.	15
UNIT III	Telescopes: Basic Optics, Types of telescopes. Telescope mounting systems. Optical telescopes, Infrared, Ultraviolet, X- ray and Gamma-ray telescopes. Schmidt telescopes. Solar telescopes. Design and construction of a simple optical telescopes. Active and adoptive optics in astronomical study. Sky charts and their importance.	15
UNIT IV	Classification of detectors, characteristics of detectors. Detectors for optical and infrared wavelength regions. Working of Charge Coupled Device (CCD). sensitivity, noise, quantum efficiency, spectral response, Johnson noise, signal to noise ratio, Application of CCD for stellar imaging, photometry and spectroscopy. Importance of space based astronomy. Observational techniques of astronomical sources from space in	15

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	infrared, EUV, X-ray and Gamma-ray of the regions electromagnetic spectrum.	
Suggested Readings: Abhyankar K. D.: Astrophysics, Galaxies and Stars Vaidyanth Basu: An Introduction to Astrophysics Motz: Astrophysics K S Krishnaswamy: Astrophysics: A Modern Perspective W. M Smart: Spherical Astronomy Mark A. Garlick: The Story of the Solar System		
Can be opted by Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites Passed Semester VIII with Physics as major		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha-DTHChannel , https://www.swayamprabha.gov.in/index.php/program/current_he/8		

MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER III c
Subject: Physics		
Course code	Course Title: High Energy Physics- I	
Course Outcomes: Students would be able understand the complex properties and behaviour of high energy particles at the microscopic level. This course would encourage students to peruse higher study and research in particle and high energy Physics.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures

UNIT I	Quantization of Scalar Fields Lagrangian Formulation, Hamiltonian and momentum densities, Neutral and Charged scalar fields and their quantization, Momentum representation and frequency splitting, Identification of various particle operators, Charge operator, Algebra of field operators, Invariant delta function and its representations, Covariant commutation relations and their properties.	15
UNIT II	Quantization of Spinor Field Lagrangian formulation for Spinor field, Hamiltonian and momentum densities, Quantization of Spinor Field, Momentum representation and frequency splitting, Identification of various particle operators, Charge operator for Spinor field, Algebra of Spinor field operators, Covariant form of anti-commutation relations.	15
UNIT III	Quantization of Electromagnetic Field Classical electromagnetic field theory and its gauge formulation, Covariant Lagrangian formulation for EM field, Quantization of EM field, Momentum representation and frequency splitting,	15
UNIT IV	Identification of various particle operators, Concept of longitudinal, temporal and transverse photons, Covariant commutation relations for EM potential operators, Problems with temporal photons and Lorentz condition, Resolution through Gupta- Bleular formulation	15
Suggested Readings: L. Ryder: Quantum Field Theory B. K. Agarwal: Quantum Mechanics and Field Theory		

F Mandel and Shaw: Quantum Field Theory P. Roman: Quantum Field Theory A. Das: Quantum Field theory M. E. Peskin, D.V. Schroeder: An Introduction to Quantum Field Theory B.S.Rajput : Advanced Quantum mechanics	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VIII with Physics as major	

Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	
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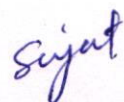
MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER III d
Subject: Physics		
Course code	Course Title: Spectroscopy-I	
Course Outcomes: In this course the students would study the various types of lasers, Laser spectroscopy and their applications in science and technology. Knowledge acquired by the course will be of much use for various industries and R&D sector .		
Credits: 4	Core Compulsory	
Max. Marks: 100 External Exam: 75 Internal assessment: 25	Min. Passing Marks: 36	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Rotational Spectra: rotational energy level populations, linear, symmetric, spherical and asymmetric top molecules, rotational selection rules for linear molecules, Stark effect in molecular rotation spectra, Molecular rotation-nuclear spin coupling, Positive and negative character of the wave functions of linear molecules, Symmetric-antisymmetric character and statistical weight of homo-nuclear linear molecule.	15
UNIT II	Vibrational Spectra: Vibration spectra of polyatomic molecule, coupling of rotation and vibration, perpendicular and parallel bands, Normal modes of vibration and their analysis in Cartesian coordinates, normal coordinates and their internal coordinates, calculation of vibrational frequencies and force field of H ₂ O and CO ₂ molecules, anharmonicity, degenerate and non-degenerate vibrations, inversion doubling, Quantized Vibrational motion of polyatomic molecules.	15
UNIT III	Electronic Spectra: Spectroscopy of Diatomic and Polyatomic Molecules: Coupling of Electronic and Rotational motion in Diatomic Molecules and Rotational structure of $1\pi - 1\Sigma$ and $1\Sigma - 1\Sigma$ transitions. Vibronic interaction and Herzberg Teller theory for absorption spectrum of benzene vapour.	15

UNIT IV	Single vibronic level spectroscopy and lifetime of vibronic levels in benzene, Quantum yield, Kasha Rule and the concept of nonradiative transitions in molecules, Jablonski diagram and qualitative treatment of small molecule and large molecule limit for nonradiative transitions.	15
Suggested Readings:		
C.N. Banwell: Fundamentals of Molecular Spectroscopy		
Walker and Stranghen: Spectroscopy Vol. I, II, & III		
Herzberg: Spectra of diatomic molecules Jeanne		
L. Mchale: Molecular Spectroscopy		
P.F. Bemath: Spectra of atoms and molecules		
J.M Holias: Modern Spectroscopy		
K. Thyagrajan and A.K. Ghatak: Lasers: Theory and applications A Yariv: Quantum Electronics		
Can be opted by		
Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites		
Passed Semester VIII with Physics as major		
Suggested Equivalent Online Courses:		
1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/		
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3 . SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

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MASTER IN PHYSICS		
Programme:MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER IIIe
Subject:Physics		
Course code	CourseTitle:-Condensed Matter Physics-I	
Course Outcomes: This course develops the basic understanding regarding the principles and concepts of condensed matter physics. The course expose student to the domain of the crystal defect and different types of magnetism. This course will also widen the knowledge behind energy band theory.The present course also enables the concept of dielectrics among the students.		
Credits:4	CoreCompulsory	
Max.Marks:100 ExternalExam:75 Internalassessment:25	Min. PassingMar ks:36	
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Electronic Properties of Solids: Electrons in periodic potential, Kronig-Penny model for band theory, brillouin zone, Effective mass, Physical interpretation of effective mass, Distinction between metals, Semiconductors and insulators, Density of state function, Density of electrons in conduction band, Density of holes in valence bands, Donor and acceptor impurities in n-type and p-type semiconductors, MetalSemiconductor junctions.	16
UNIT II	Dielectric and electrical properties of insulators: Macroscopic description of dielectric constants, static, electronic and ionic polarizability of molecules, orientational polarization, Internal Lorentz field static dielectric constant, Complex dielectric constant, Dielectric loss and relaxation time, Optical absorption.	14

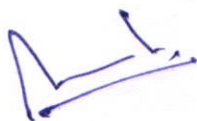




UNIT III	Magnetism: Dia, Para and ferromagnetism, Langvin's theory of paramagnetism, Ferromagnetism, Quantum theory of dia and para magnetism, Weiss molecular theory, Ferromagnetic domains, Anti-ferromagnetism, Neel's theory, Two sub-lattice model, ferrites.	15
UNIT IV	Defects in crystals: Point defect, Impurities, Vacancies, Frenkel defects, Schottky defects, Intrinsic vacancies, Concentration of Schottky defects, Concentration of frankel defects, extrinsicvacancies, Diffusion, Colour centres, F-Centre, V-Centre, dislocation, Line defects, edge dislocation, screw dislocation, Burger vector.	15
SuggestedReadings: 1. Kittel C., Introduction to Solid State Physics, Willey Publication, 2008. 2. Ziman J.M, Principles of theory of solids, Cambridge University Press, 2013. 3. Callaway J., Quantum theory of solids, Elsevier, 1976. 4. Dekker A. J., Solid State Physics, Prentice Hall, 1962. 5. Animalu A.O. E, Intermediate Quantum theory of crystalline solids, PrenticeHall, 1977.		

6. Ashcroft N. W. and Mermin N. D., Solid State Physics, Holt, Rinehart and Winston, 1976.	
7. Saxena A. K.,Solid State Physics, Laxmi Publication, 2017.	

Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VIII with Physics as major	
Suggested Equivalent Online Courses: 4. MITOpenLearning- MassachusettsInstituteofTechnology, https://openlearning.mit.edu/ 5. NationalProgrammeonTechnologyEnhancedLearning(NPTEL), https://www.youtube.com/user/nptelhrd 6. SwayamPrabha -DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	




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MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER IV a
Subject: Physics		
Course code	Course Title: Advanced Electronics- II	
Course Outcomes: This course helps the students to gain basic ideas of the digital communication, optical communication, memory and optoelectronic devices. The course is of much practical purpose for the students to learn advanced concepts of digital communication systems.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Modulation Techniques: Angle modulation (PM & FM), relation between PM & FM, FM generation (direct, varactor diode & reactance tube methods), frequency demodulators (slop & balanced slope method), pulse modulation (PAM & PWM) and demodulation, discretization in time and amplitude, concept of quantization, pulse code modulation (PCM), basic idea of digital telemetry and digital signal processing.	15
UNIT II	Microwave production and Microwave Communications: Microwave frequencies, advantages of microwaves, limitation of conventional electronic devices at UHF, microwave measurements devices and instrumentation, measurement of power, principle of velocity modulation, two cavity klystron, reflex klystron, transferred electron devices (TEDs), Gunneffect diodes (GaAs diode only): RWH theory, mode of operation. Satellite communication.	15
UNIT III	Fiber Optics: Evolution of fiber optics, advantages and classification of fibers, acceptance angle, numerical aperture, propagation of light waves in step index and graded index fibers, optical fiber modes and configurations, attenuation in optical fibers, light sources, detectors and their characteristics, optical communication system, optical fiber sensors: intensity modulated and interferometric optical fiber sensors.	15

UNIT IV	Power Supply Regulation: Load regulation, line regulation and output resistance of a power supply, shunt & series regulators and their short circuit protection, monolithic linear regulators: classification, LM78XX & LM79XX series, regulated dual supplies and adjustable regulators, current boosters and their short circuit protection, unregulated DC to DC converters, switching regulators: buck, boost and buck-boost regulators, Precision rectifier.	15
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Suggested Readings:	
1. 'Electronic Principles' - A.P. Malvino, TMH Publishing Company Limited. 2. 'Microwave Devices and Circuits' - S.Y Liao, PHI Private Limited. 3. 'Microwave and Radar Engineering' - M. Kulkarni, Umesh Publications. 4. 'Communication Systems - Analog & Digital', R.P. Singh and S.D. Sapre, TMH 5. 'Fundamentals of Fiber Optics in Telecommunication and Sensor, Ed.- B. Pal, New Age International (P) Limited. 6. 'Optical Fiber Communications, Principles and Practice', J.M. Senior, Pearson Education 7. 'Optical Fiber Communications', G. Keiser, TMH Publishing Company Limited.	
Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites	
Passed Semester VIII with Physics as major	
Suggested Equivalent Online Courses:	
1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3 3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER IV b
Subject: Physics		
Course code	Course Title: Astrophysics –II	
Course Outcomes:		
The Course will provide the deeper understanding of the radiative transfer and the interaction of radiation with matter. It would be important to understand the physics of the death of stars. This study is crucial for the deeper knowledge of the neutron stars, white dwarfs and black holes. Their study provides the insight for the gravitational waves.		
Credits: 4	Core Compulsory	

Max. Marks: 100		Min. Passing Marks: 36
External Exam: 75		
Internal assessment: 25		
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Radiation transfer: Definitions of specific intensity, mean intensity, flux and energy density; Equation of radiation transfer; solutions in some specific cases, optical depth; Thermal emission; Blackbody spectrum and its characteristics; Kirchoff's law; Einstein coefficients.	15
UNIT II	Interior Properties of Stars Hydrostatic equilibrium, Virial theorem, Polytropic indices, Lane – Emden equation LTE, Radiative equilibrium, stability condition of convective and radiative equilibrium, Continuous spectra of stars, Stellar opacity, limb darkening, line blanketing, theory of Fraunhofer lines, curve of growth and line broadening.	15
UNIT III	Elementary theory of white dwarfs, Chandrashekhar's limit for white dwarf stars, neutron stars their birth and properties, Pulsars, black holes, low medium mass star and high mass stars, death of high mass stars, supernova remnants..	15
UNIT IV	AGNs and Quasi-stellar Objects Theory of AGNs, Syferts, quasars and their energy generation and redshift anomaly. Different AGN models, radio lobes and jets, Gamma ray bursts.	15
Suggested Readings: Abhyankar K.D.: Astrophysics, Galaxies and Stars Vaidyanth Basu: An Introduction to Astrophysics motz: Astrophysics A. R. Choudhuri : Astrophysics for Physicists		

B. D. Abhyankar: An Introduction to Astrophysics	
T. Padmanabhan : Astrophysical Processes	
Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites	
Passed Semester VIII with Physics as major	

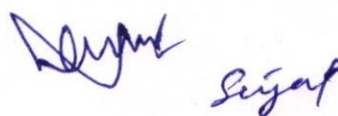
Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,
<https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning
(NPTEL), <https://www.youtube.com/user/nptelhrd3>. SwayamPrabha -
DTH Channel,
https://www.swayamprabha.gov.in/index.php/program/current_he/8


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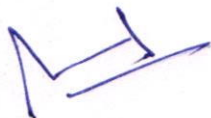
MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER IV c
Subject: Physics		
Course code	Course Title: High Energy Physics-II	
Course Outcomes: The course would provide the knowledge of basic building blocks of matter and its complex properties. The students will also be able to know the complicated theory of Higgs mechanism which led to the detection of God particle in LHC experiment in the year 2012. It would open doors for the students who want to work in the field of HEP.		
Credits: 4	Core Compulsory	
Max. Marks: 100 External Exam: 75 Internal assessment: 25	Min. Passing Marks: 36	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Lie Groups and Lie Algebra Symmetries, Groups and conservation laws, Lie groups and their generator, representation of the groups, Lie Algebra, Different dimensions and parameter groups-their generators and algebra, Simple and semi-simple Lie Algebra, Standard form of Lie Algebras, Root diagrams for groups of different rank.	15
UNIT II	Quark Model Fermi Yang model, Sakata model, Necessity of Quark model, Shortcomings of Eight fold way, Gell - Mann Zweig model, Quark-Lepton symmetry and structure of Hadrons, Need of charm quantum number and charmed quark, Elementary idea of charm, bottom and top quarks, Baryon magnetic moments in quark model, Experimental status of Quarks.	15
UNIT III	Gauge Field Theories Concept of gauge fields and gauge connections, Principle of gauge invariance, Global and local Abelian gauge invariance, U(1) gauge invariance of QED.	15
UNIT IV	Yang- Mills gauge field, Non-Abelian gauge field theory (SU(2) case), Concept of spontaneous symmetry breaking and Goldstone Bosons, Higgs Mechanism with physical examples and mass generation for gauge fields	15
Suggested Readings: .E. Close: Quarks and Patrons D.C. Cheng and O Neil: Elementary Particle Physics P.Cheng and G. LF Li: Gauge Field Theory I. J. Aitchison and A. J. Hey: Gauge theories in Particle Physics H. Georgi : Lie Algebras in particle Physics		

D. B. Lichtenberg : Unitary Symmetry and Elementary Particles, Academic Press, 1978	
Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VIII with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER IX PAPER IV d
Subject: Physics		
Course code	Course Title: Spectroscopy -II	
Course Outcomes: In this course the students would study the various types of lasers, Laser spectroscopy and their applications in science and technology. Knowledge acquired by the course will be of much use for various industries and R&D sector .		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Radiation and Matter Interaction of radiation with matter, Einstein quantum theory of radiation, Einstein's coefficients, Momentum Transfer, Lifetime, Theory of optical frequencies, Coherence Spatial and temporal and Monochromaticity, kinetics of optical absorption, line width, line broadening mechanisms.	15
UNIT II	Basic Elements of Lasers Spontaneous emission, Stimulated emission, Possibility of amplification, laser pumping, Population Inversion, Three and four level scheme, Threshold condition, rate equations, Active resonators & laser modes, gain saturation.	15
UNIT III	Type of Lasers Different types of lasers, gas lasers, He-Ne laser, N ₂ & CO ₂ lasers dye lasers, solid state lasers, Nd-YAG, semiconductor lasers. Tunability of lasers	15
UNIT IV	Applications of Lasers Basic application of laser spectroscopy, laser cooling and trapping of atoms etc.	15
Suggested Readings: Banwell: Fundamentals of Molecular Spectroscopy Walker and Stranghen: Spectroscopy Vol. I, II, & III Herzberg: Spectra of diatomic molecules Jeanne L Mchale: Molecular Spectroscopy .F. Bemath: Spectra of atoms and molecules M Holias: Modern Spectroscopy K. Thyagrajan and A.K. Ghatak: Lasers: Theory and applications A Yariv: Quantum Electronics		

Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites	
Passed Semester VIII with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	





MASTER IN PHYSICS		
Programme:MASTER IN PHYSICS	YEARV	SEMESTER IX PAPER IVe
Subject:Physics		
Course code	CourseTitle: Condensed Matter Physics -II	
CourseOutcomes:		
The present syllabus provides knowledge about the basic concepts, principles and the various properties exhibited by condensed matter, especially solids to the students.The course widens the domain knowledge of ferroelectrics.The course also develops the basics knowledge of superconductors and their properties.This course also deals with the topics like transport properties and magnetic resonance, and imparts knowledge to the students.		
Credits:4		Core Compulsory
Max.Marks:100 ExternalExam:75 Internalassessment:25		Min.Passing Marks: 36
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):4-0-0		
UNIT	TOPIC	No. ofLectures
UNIT I	Nearly free electron model: One dimensional free electron case, Nearly free electron case, energy bands in one dimension, tight binding approximation, energy surfaces, Wigner Seitz cellular method, Orthogonalized plane wave (OPW) method, Pseudopotential method, Limitations of band theory (Mott Transition)	15
UNIT II	Ferroelectrics Materials: Structural phase transition, ferroelectric crystals, classification of ferroelectric crystals, displacive transition, soft optical phonons, Landau theory of phase transition, Second and first order transition, optical absorption, transmission and reflection. antiferroelectricity, ferroelectric domains.	15
UNIT III	Superconductivity: Experimental Survey, Occurrence of superconductivity, destruction of superconductivity by magnetic field and temperature, Meissner effects, Type-I and Type-II superconductors, Isotope effect, Thermodynamics of Superconducting transition, London Equations, Coherence length, BCS Theory, Cooper pairs, Josephson superconductor tunneling, AC & DC Josephson effect, High temperature superconductors, critical fields and critical currents.	15

Subject

UNIT IV	Transport properties and magnetic resonance: Sommerfeld theory of electrical conductivity, Boltzmann transport equation, Relaxation time, Experimental determination of Hall coefficient, Residual resistivity, Temperature dependent resistivity, Principle of magnetic resonance, Nuclear magnetic resonance, Electron spin resonance, Resonance, Fluorescence, Theory of Mössbauer effect, Isomer shift, Quadrupole interaction, magnetic hyperfine interaction.	15
	Suggested Readings: 1. Lubensky T.C. and, Chaikimand P.M., Principle of condensed matter Physics, Cambridge University Press, 2012. 2. Ryogo K., Solid State Physics, McGraw-Hill, 1969. 3. Srivastava, J. P, Elements of Solid State Physics, Prentice Hall of India, 2006. 4. Otfried M., Introduction to Solid State Physics, Spinger, 1978. 5. Patterson J., and Bernard C., Introduction to Solid State Physics, Springer, 2007. 6. Kittel C., Introduction to solid state Physics, Wiley, 2008. 7. Ashcroft N. and Mermin N., Solid State Physics, Cambridge University Press, 1976. 8. Saxena A. K., Solid State Physics, Laxmi Publication, 2017.	
	Can be opted by Bachelor in Science with Physics as major subject	
	Suggested Continuous Evaluation Methods:	
	Course Prerequisites Passed Semester VIII with Physics as major	
	Suggested Equivalent Online Courses: 7. MITOpenLearning- MassachusettsInstituteofTechnology,https://openlearning.mit.edu/ 8. NationalProgrammeonTechnologyEnhancedLearning(NPTEL),https://www.youtube.com/user/nptelhrd 9. SwayamPrabha -DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8	

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MASTER IN PHYSICS			
Programme: MASTER IN PHYSICS		YEAR IV	SEMESTER IX/PAPER V
Subject: Physics			
Course code	Course Title: PRACTICAL		
Course Outcomes:			
The student will have adequate knowledge to perform the experiments of different fields of physics with clear understanding of the theory behind the experiment.			
Student will know about various electronics experiments and some advanced experiments in Physics			
Credits: 4			Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25			Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			
UNIT	List of Experiments	No. of Lectures	
	1. Verification of Richardson's law. 2. Study of ESR spectra of a given sample. 3. Hall Effect 4. RCS Spectrometer 5. Gamma ray spectrometer 6. Radio Receiver 7. e by Millikan's oil drop method. 8. Temperature dependence of diode characteristics. 9. Elastic constants of a cubic crystal by ultrasonic waves. 10. Study of Multivibrators. 11. Study of transistor amplifier cum feedback amplifiers. \n 12. Study of absorption of KMnO4 by Spectrophotometer 13. Study of different FETs and MOSFETs. 14. Study of Thermo luminance. 15. Study of VTVM.	60	
Can be opted by			
Bachelor in Science with Physics as major subject			
Suggested Continuous Evaluation Methods:			

Course Prerequisites Bachelor in Science with Physics as major subject	
Suggested Equivalent Online Courses: 1. Virtual Labs at Amrita Vishwa Vidyapeetham,	
https://vlab.amrita.edu/?sub=1&brch=74 2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities	




Sujat

MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER X PAPER I
Subject: Physics		
Course code	Course Title: Nuclear Physics	
Course Outcomes: In this course students would know about the general properties of nuclei, nuclear forces and detectors, radioactive decay and nuclear reactions. The course builds a foundation for the students to carry out research in the field of nuclear physics, high energy physics, nuclear astrophysics, nuclear reactions and applied nuclear physics.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Nuclear Properties and Nuclear Models Concepts of Atomic Nuclear-Size, Shape, charge distribution, spin & parity, magnetic moment; electric quadrupole moment; binding energy; semi-empirical mass formula, mirror nuclei, Liquid drop model, Experimental evidence for shell effects, Shell model, Magic numbers, Spin orbit coupling, Single particle shell model-its validity and limitations; collective model.	15
UNIT II	Nuclear Forces and Nuclear Interactions Theory of Deuteron and nuclear level properties, nucleon - nucleon interactions, low & highenergy nucleon-nucleon scattering, Yukawa's Meson theory of nuclear forces, Spin dependence and charge independence of nuclear forces.	15
UNIT III	Nuclear Reactions Kinds of nuclear reactions; Conservation laws; Nuclear reaction Kinematics; charge particle reaction spectroscopy; neutron spectroscopy; nuclear cross-section; compound nucleus; Nuclear transmutations, continuum theory of nuclear reaction, Nuclear fission, Chain reactions, Nuclear fusion, Thermonuclear reactions.	15
UNIT IV	Nuclear Decays Basic understanding of α and β - decay, Fermi theory of beta decay, selection rules in β -decay, Neutrino hypothesis, Parity violation in beta decay, K capture and internal conversion.	15

Suggested Readings: E. Burcham: Nuclear Physics Ervin Kaplan: Nuclear Physics Roy & Nigam: Nuclear Physics S. N. Ghoshal: Atomic and Nuclear Physics A. Enge: Nuclear Physics .D. Evans: Nuclear Physics E. Segre: Nuclei and Particles H.M. Agrawal: Nuclear Physics, PHI Learning	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester IX with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS			
Programme: MASTER IN PHYSICS		YEAR V	SEMESTER X PAPER II
Subject: Physics			
Course code		Course Title: Digital Electronics and Computer Architecture	
Course Outcomes: The course enables student to get knowledge about Digital Electronics and Computer Architecture. The course includes Fundamentals of Digital Circuit, Computer Organization and Architecture , Instruction formats & Microprocessor, Data Communication, Computer and Communications.The course helps student to work for the development of technology and also the for the industry and various Government organizations.			
Credits: 4			Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25			Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	TOPIC		No. of Lectures

UNIT I	Digital Circuit & Microprocessor Elementary idea of combinational and sequential circuits, Overview of Microcomputer organization and operation, Microprocessor evolution and types, Fundamental knowledge of Microprocessor (8085/8086), Architecture and its operation, Basic idea of logic devices for interfacing 8085/8086.	15
UNIT II	Computer Organization and Architecture Central Processing Unit, Computer organization, Instruction formats (e.g. Three address, Two address etc), addressing modes, Timing diagram, Interconnection of different units, I/O to processor and processor to memory communication, Interrupt structures, Multiprogramming, processor features RISC, CISC, cache memory, real and virtual memory.	15
UNIT III	Data Communication Computer and Communications, Need for communication networks, Internet and World Wide Web, communication protocols, Local Area Networks, Interconnecting networks, Future of Network Technology.	15
UNIT IV	Computer Network Characteristics of communication channels, Allocation of Channels, Physical Communication media, Public Switched Telephone Network, Cellular Communication Path, ATM networks	15
Suggested Readings: Morris Mano : Computer system Architecture, (PHI) (Eastern Economy Edition)		

V. Rajaraman: Fundamentals of computers, (Prentice Hall of India) Morris Mano: Computer system architecture, (Eastern Economy Edition) B. Ram: Computer fundamental-architecture and organization (New Age International Publishers) Tanen Bomm: Computer Network Ramesh Gaonkar: Microprocessor, Architecture, programming and application with the 8085 Hafizer Rehaman: Microprocessor programming and Interfacing Intel 8085 and 8086	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	

Subject

Course Prerequisites Passed Semester IX with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS			
Programme: MASTER IN PHYSICS		YEAR V	SEMESTER X PAPER III A
Subject: Physics			
Course code		Course Title: Advanced Electronics-III	
Course Outcomes:			
This course helps the students to gain advanced concepts of power supply regulation, microwave production and microwave generation which has wide applications in modern industry and Research.			
Credits: 4			Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25			Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	TOPIC		No. of Lectures
UNIT I	Integrated Circuit Technology: Classification of IC's, crystal growth and wafer preparation, monolithic IC processes: oxidation, photo and fine line lithography, wet and dry etching, diffusion and ion implantation, epitaxial growth and metallization, fabrication of IC components: resistors, capacitors, diodes and bipolar transistor.		15
UNIT II	Operational Amplifier (OA): Differential amplifier and its configurations, DC and AC analysis of differential amplifier, CMRR, operational amplifier, circuit type of OA 741, effects of offset, virtual ground, virtual short, inverting and noninverting amplifier.		15
UNIT III	Linear Analog systems: Summing and difference amplifier, voltage follower, OA as log and antilog amplifiers, multiplier, voltage to current converter, current to voltage converter, integrator and differentiator.		15
UNIT IV	Non-Linear Analog Systems: Comparator, sample and hold circuit, IC 555 timer, waveform generator, instrumentation amplifier, precision rectifier, active filters (first order only), Phase Locked Loop.		15

Sujat

Suggested Readings: 1. 'Operational Amplifiers and Linear Integrated Circuits' - R.F. Coughlin and F.F. Driscoll, PHI Private Limited. 2. 'Op-Amps and Linear Integrated Circuits' - R.A. Gayakwad, PHI Private Limited. 3. 'Integrated Circuits' - K.R. Botkar, Khanna Publishers. 4. 'Fundamentals of Semiconductor Fabrication' - G.S. May and S.M. Sze, John Wiley & Sons, Inc.	
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Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester IX with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	



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MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER X PAPER III B
Subject: Physics		
Course code	Course Title: Astrophysics-III	
Course Outcomes: This course provides the basic physical mechanisms about the solar activities, which will help to probe the Sun- Earth connection. This study provides the knowledge of Astroseismology, classification of stars and the distribution in Galaxies.		
Credits: 4	Core Compulsory	
Max. Marks: 100 External Exam: 75 Internal assessment: 25	Min. Passing Marks: 36	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Sun as a star : Solar spectrum, effective temperature, luminosity, photospheric absorption lines, limb darkening; energy source: Kelvin time scale, nuclear fusion; energy transport in the sun, Thomson scattering, mean free path, photon diffusion inside the Sun; photosphere, chromosphere, transition region, corona.	15
UNIT II	Quiet and Active Sun, Sunspots, their formation and magnetic field, Solar flares, Solar filaments/prominences, Coronal mass ejections (CMEs), Solar wind, Different type of solar eruptions models, Coronal heating, Origin of solar cycle.	15
UNIT III	General idea of Heliosesmology, Astroseismology, Description about p-mode and g-mode oscillations, Introduction to variable stars and their locations in H-R diagram. Classifications, Cepheids variables (classic Cepheids and W Virginis stars), RR Lyrae stars, Mira variables, Eruptive variables, Flare stars, Nebular variables, Supernovae, roAP stars	15
UNIT IV	The Milky way and Other Galaxies Distributions of stars in the Milky way, Morphology, Kinematics, Interstellar medium, Galactic center. External galaxies, Types of galaxies: spirals, ellipticals and irregulars, Hubble classification for galaxies, 21cm line, rotation cure, dark matter.	15
Suggested Readings: Stix: The Sun: An Introduction K. D. Abhyankar : Astrophysics: Stars and Galaxies		

T. Padmanabhan : Galaxies and Cosmology	Motz : Astrophysics
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Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester IX with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology; https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	




Sujat



MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER X PAPER III C
Subject: Physics		
Course code	Course Title: Hight Energy Physics-III	
Course Outcomes: The course would provide the knowledge of advanced concepts of HEP. The students will be able to know the complicated theory of Relativistic propagators, S matrix expansion and S matrix formulation of QED. It would open doors for the students who want to work in the field of HEP.		
Credits: 4	Core Compulsory	
Max. Marks: 100 External Exam: 75 Internal assessment: 25	Min. Passing Marks: 36	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Relativistic Propagators Relativistic propagators using quantized formulation of free fields, Properties of quantized scalar fields(Real and complex cases), Algebra of field operators, covariant form of the field operators algebras, (Covariant commutation relations), Meson propagator and its characteristics, Properties of quantized spinor fields, Algebras of spinor field operator, Covariant form of anti-commutation relations, Fermion propagator and its characteristics, properties of quantized EM field, Covariant commutation relations of EM field operators, Photon propagator and its characteristics, EM interaction in terms of radiation field and instantaneous coulomb fields.	15
UNIT II	Operator Products, Feynman Propagators and S-matrix Expansion Various type of operator products (Normal, Dyson products and Chronological T-products), Wick's theorem, Feynman propagators and its physical interpretation, Interacting fields, S-Matrix formulation as a perturbative series solution of collision processes, Dyson expansion of S-matrix.	15
UNIT III	S-matrix Formulation of QED Interaction Hamiltonian in QED, Reduction of S-matrix for the case of QED, Representation and description of various first and second order processes in QED using S-matrix expansion.	15
UNIT IV	Compton scattering, Moller scattering, Bhabha scattering, Electron self energy, Photon self energy, vacuum configuration in QED, Feynman diagrams and Feynman Rules in QED.	15

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Suggested Readings: Ryder: Quantum Field Theory B.K. Agarwal: Quantum Mechanics and Field Theory F Mandel and G. Shaw: Quantum Field Theory Roman: Quantum Field Theory A. Das: Quantum Field theory M. E. Peskin, D.V. Schroeder: An Introduction to Quantum Field Theory	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester IX with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha-DTHChannel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

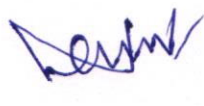
MASTER IN PHYSICS			
Programme: MASTER IN PHYSICS		YEAR V	SEMESTER X PAPER III D
Subject: Physics			
Course code	Course Title: Spectroscopy-III		
Course Outcomes: In this course the students would study the various types of lasers, Laser spectroscopy and their applications in science and technology. Knowledge acquired by the course will be of much use for various industries and R&D sector .			
Credits: 4			Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25			Min. Passing Marks: 33
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	TOPIC		No. of Lectures

UNIT I	Molecular Symmetries and Group Theory Symmetry Properties of molecule: symmetry element, symmetry operation and point group, character table, Group theory: representation of a group, reducible and irreducible representations, LCAO coefficient of a polyatomic molecule, Huckel approximation, overlap and resonance integrals, Wheel's approximation.	15
UNIT II	Mechanism of Fluorescence Emission and decay mechanism, radiative & nonradiative processes, Jablonski diagram, Kasha rule, Fluorescence lifetime and quantum yield, stoke shift, Mirror image rule, Oscillator strength, Fluorescence polarisation and Anisotropy, Time scale of molecular processes in solution .	15
UNIT III	Instrumentation for Fluorescence Spectroscopy Excitation and Emission spectra, An ideal spectrofluorometer Distribution in Excitation & Emission spectra, Light sources, Monochromator,	15
UNIT IV	Optical filters, Photomultiplier tubes, Photon counting versus Analog detection of Fluorescence Corrected Fluorescence spectra, Measurement of Fluorescence lifetime	15
Suggested Readings: Barrow G. M: Introduction to Molecular spectroscopy; McgrawHill Herzberg G: Infrared and Raman Spectra of Polyatomic Molecules; Von Nostrand Herzberg G: Spectra of Polyatomic Molecules; on Nostrand J. R. Lackowicz: Principle of Fluorescence		
Spectroscopy King G: Molecular Spectroscopy		
King G.W: Spectroscopy and Molecular Structure		
Can be opted by		
Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites Passed Semester IX with Physics as major		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3 .SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8		

MASTER IN PHYSICS		
Programme:MASTER IN PHYSICS	YEARV	SEMESTERX PAPERIIIe
Subject: Physics		
Course code	CourseTitle: Condensed Matter Physics -III	
CourseOutcomes: The present syllabus provides knowledge about the basic concepts, principles and the various properties exhibited by condensed matter, especially solids to the students.The course widens the domain knowledge of synthesis of nanomaterials.The course also develops the basics knowledge of carbon nanotubes to the students.		
Credits:4	Core Compulsory	

Max.Marks:100 ExternalExam:75 Internalassessment:25		Min.Passi ng Marks:36
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):4-0-0		
UNIT	TOPIC	No. ofLectures
UNITI	Nanoscale Systems: Nano science, Nano technology Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences..	15
UNITII	Synthesis of Nanomaterials-I : Physical Methods: Top-down vs. Bottom-up Technique, Nonlithographic Techniques: Plasma Arc Discharge, Sputtering, Electron Beam and Thermal Evaporation, Pulsed Laser Deposition, Molecular Beam Epitaxy. Lithographic Process and its Limitations: Electron beam lithography, Ion beam lithography, Photo lithography, x-ray lithography.	15
UNITIII	Synthesis of Nanomaterials-II: Chemical Methods: Chemical Vapor Deposition (CVD), Solgels techniques, Co-precipitation, Hydrothermal, Spin and Dip coating techniques and Spray pyrolysis, Chemical Etching Techniques, Electroplating, Langmuir Blodgett(L-B) method, microemulsions.	15
UNITIV	Carbon based Nanomaterials: Introduction to Carbon Clusters, CNTs and synthesis of carbon nanotubes.Growth mechanism, electronic structure of carbon nanotubes, preparation and characterization of fullerenes and graphene.Nanodiamond, Defects and purifications in CNT(Brief).	15
SuggestedReadings: 1. Lubensky T.C. and, Chaikimand P.M., Principle of condensed matter Physics, Cambridge University Press, 2012. 2. Ryogo K., Solid State Physics, McGraw-Hill, 1969. 3. Srivastava, J. P, Elements of Solid State Physics, Prentice Hall of India, 2006. 4. Otfried M., Introduction to Solid State Physics, Springer, 1978. 5. Patterson J., and Bernard C., Introduction to Solid State Physics, Springer, 2007. 6. Kittel C., Introduction to solid state Physics, Wiley, 2008. 7. Ashcroft N. and Mermin N., Solid State Physics, Cambridge University Press, 1976. 8. Saxena A. K., Solid State Physics, Laxmi Publication, 2017.		

Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VIII with Physics as major	
Suggested Equivalent Online Courses: 10. MITOpenLearning- MassachusettsInstituteofTechnology, https://openlearning.mit.edu/ 11. NationalProgrammeonTechnologyEnhancedLearning(NPTEL), https://www.youtube.com/user/nptelhrd 12. SwayamPrabha -DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

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MASTER IN PHYSICS			
Programme: MASTER IN PHYSICS		YEAR V	SEMESTER X PAPER IV A
Subject: Physics			
Course code	Course Title: Advanced Electronics-IV		
Course Outcomes: This course helps the students to gain basic ideas of the construction and working of electronic devices and circuits. The course includes the study of combinational circuits, sequential circuits and analog computation. The course is of much practical purpose for the students to learn basics of digital electronics. The digital electronics has wide applications in computing, process control, signal processing, communication systems, digital instruments etc.			
Credits: 4			Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25			Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
UNIT	TOPIC	No. of Lectures	
UNIT I	Review of logic devices: logic gates, tristate switch, Buffer, Decoder, Encoder and D-Flip-flops, RAM, ROM, etc., generic microcomputer, architecture of a microprocessor, 8085 microprocessor architecture.	15	
UNIT II	Instructions-I:8085 instruction set, data transfer operations, arithmetic operations, logic operations, branch operations, stack and subroutines, restart, conditional call and return instruction, writing assembly language programs, debugging a program.	15	
UNIT III	Instructions-II: 8085 timing processes, opcode fetch, machine cycle, read and write cycle timing, interrupt acknowledge timing, timing diagrams of different instructions, 8085 interrupts, 8085 vectored interrupts, serial I/O lines (SID & SOD).	15	
UNIT IV	Interfacing of devices: memory mapping, I/O mapping, memory interfacing- interfacing of 4K × 8, 8K × 8 and 16K × 8 memory chips, interfacing I/O devices, architecture and programming of 8255 (PPI), 8251 (USART), and idea of other peripherals.	15	
Suggested Readings: 1. 0000 to 8085, Introduction to microprocessors for engineers and scientists: P.K. Gosh and P.R. Sridhar (PHI) 2. Microprocessor Architecture, programming, and applications with the 8085: Ramesh Gaonkar (Penram)			

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Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester IX with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha-DTHChannel , https://www.swayamprabha.gov.in/index.php/program/current_he/8	

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Washu

Sujal

MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER X PAPER IV B
Subject: Physics		
Course code	Course Title: Astrophysics-IV	
Course Outcomes: This course will provide the basic properties of stars, birth and the evolution of stars. In addition of this, it provides the deep understanding about the star clusters and their properties, e.g. luminosity and mass function, mass-luminosity relations etc.		
Credits: 4	Core Compulsory	
Max. Marks: 100 External Exam: 75 Internal assessment: 25	Min. Passing Marks: 36	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Basic Properties of Stars: Mass, radius, distance, luminosity, temperature, magnitude system, Wien-displacement colour indices, filters, H-R diagram, classification of stellar spectra, luminosity classification, stellar motion, stellar populations	15
UNIT II	Star Formation and Stellar Evolution: Birth of stars, protostar, Pre- main sequence evolution: Jeans instability, star formation, Hayashi track, Zero age main sequence (ZAMS), Post-main sequence evolution: Core He burning, shell burning, red giant phase, planetary nebulae, white dwarf physics, electron degeneracy pressure, energy generation in stars – gravitational contraction, pp chain, CNO cycle and triple alpha process, stellar life, cycles-Pre-main sequence, main sequence, giants.	15
UNIT III	Star Cluster and their Properties: Open clusters, globular clusters and the galaxy itself are examples of 'stellar systems'; crossing time; mean potential and total potential energy in a constant density sphere; equation of motion of N-body stellar system; total momentum, angular momentum and energy as constants of motion, stellar population, population I and II type objects, inter-stellar extension, reddening determination from color color diagram, age and distance determination of star clusters, luminosity function, mass function, mass segregation, mass-luminosity relation.	15
UNIT IV	Cosmological Models: Universe at large scales – Homogeneity and isotropy – distance ladder – Newtonian cosmology - expansion and redshift - Cosmological Principle - Hubble's law - Robertson-Walker metric - Observable quantities – luminosity and angular diameter distances - Horizon distance- Dynamics of Friedman- Robertson-Walker models: Friedmann equations.	15

Suggested Readings: Abhyankar K. D.: Astrophysics, Galaxies and Stars Vaidyanth Basu: An Introduction to Astrophysics Motz: Astrophysics T. Padmanabhan: Stars and Stellar Systems L Kutner: Astronomy: A Physical Perspective	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester IX with Physics as major	
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology, https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd3.SwayamPrabha-DTHChannel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	

MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER X PAPER IV C
Subject: Physics		
Course code	Course Title: High Energy Physics-IV	
Course Outcomes: The course would provide the knowledge of some more advanced concepts of HEP. The students will also be able to know the detailed theory of weak interactions, electromagnetic interactions and strong interaction.		
Credits: 4		Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25		Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures

UNIT I	Theory of Weak Interactions Classification of weak interaction in terms of Leptonic, Semi-leptonic and Non-Leptonic weak Decays, Current-Current Interaction and VA theory, Intermediate Vector Boson (IVB) concept, Conservation of Vector Current (CVC) Hypothesis, Two Component Theory of Neutrino, W and Z bosons as weak gauge bosons.	15
UNIT II	Theory of Electromagnetic Interactions Electron Positron Annihilation into Hadrons, Electron- Nucleon Scattering, Rutherford and Mott scattering, Electromagnetic form factors of Hadrons, Structure of nucleons, Elementary Idea of Unification of Fundamental Interactions with reference to standard model of electro weak unification.	15
UNIT III	Strong Interactions Paradoxes of Naive Quark Model, Need of color quantum Number for Quarks, Color SU(3) and Gluons, Quantum Chromodynamics, Pion-Nucleon Scattering,	15
UNIT IV	Spin Classification of Hadrons and Regge Trajectories, Asymptotic freedom and Perturbative QCD, Experimental indication for quarks and gluons, String model of hadrons and confinement of Quarks.	15
Suggested Readings: E Close: Quarks and Patrons I.J. Aitchison and A.J. Hey: Gauge theories in Particle Physics F. Haltzin& A.D. Martin: Quarks and Leptons D.H. Perkins : Introduction of High Energy Physics, Cambridge University Press 2000		

P. Cheng and G. LF Li: Gauge Field Theory ED Commins: Weak Interactions D.C. Cheng and O Neil: Elementary Particle Physics	
Can be opted by Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester IX with Physics as major	

Suggested Equivalent Online Courses:

1. MIT Open Learning - Massachusetts Institute of Technology,
<https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning
(NPTEL), [https://www.youtube.com/user/nptelhrd3.SwayamPrabha -
DTH Channel,](https://www.youtube.com/user/nptelhrd3.SwayamPrabha-DTHChannel)
https://www.swayamprabha.gov.in/index.php/program/current_he/8

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MASTER IN PHYSICS		
Programme: MASTER IN PHYSICS	YEAR V	SEMESTER X PAPER IV D
Subject: Physics		
Course code	Course Title: Spectroscopy-IV	
Course Outcomes: In this course the students would study the various types of lasers, Laser spectroscopy and their applications in science and technology. Knowledge acquired by the course will be of much use for various industries and R&D sector .		
Credits: 4	Core Compulsory	
Max. Marks: 100 External Exam: 75 Internal assessment: 25	Min. Passing Marks: 36	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
UNIT	TOPIC	No. of Lectures
UNIT I	Ultrashort Pulses and Dynamics of Laser Processes Production of giant pulse, Q-switching by different types of shutters, giant pulse dynamics, laser amplifiers, mode locking, mode pulling, ultra shot pulses, hole burning, holography	15
UNIT II	Non-Linear Optics Harmonic generation, phase matching, second harmonic generation, third harmonic generation, optical mixing, parametric generation of light, self focusing of light.	15
UNIT III	Multi Photon Processes Multi quantum photoelectric effect, two photon processes, frequency up-conversion.	15
UNIT IV	Stimulated Raman effect, coherent stokes & anti-stokes Raman scattering, photo acoustic spectroscopy	15
Suggested Readings: D. Levenson: Introduction to non-linear laser spectroscopy B. Laud: Laser and non-linear optics Svelto: Lasers Demtroder: Laser Spectroscopy		
Can be opted by Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites Passed Semester IX with Physics as major		
Suggested Equivalent Online Courses: 1. MIT Open Learning - Massachusetts Institute of Technology,		

<https://openlearning.mit.edu/>

2.National Programme on Technology Enhanced Learning (NPTEL),

[https://www.youtube.com/user/nptelhrd3.SwayamPrabha - DTH Channel,](https://www.youtube.com/user/nptelhrd3.SwayamPrabha-DTHChannel)

https://www.swayamprabha.gov.in/index.php/program/current_he/8

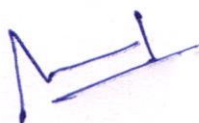
MS

Sujat

MASTER IN PHYSICS		
Programme:MASTER IN PHYSICS	YEARV	SEMESTERX PAPERIVe
Subject:Physics		
Course code	CourseTitle: Condensed Matter Physics -IV	
CourseOutcomes: This course develops the fundamental understanding of of various characterization techniques. The course covers the in details X-ray diffraction, SEM, TEM etc.		
Credits:4	Core Compulsory	
Max.Marks:100 ExternalExam:75 Internalassessment:25	Min. PassingMar ks:36	
TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):4-0-0		
UNIT	TOPIC	No. of Lectures
UNITI	Structural Characterization and Analysis: Introduction to materials characterization, Bragg's Law, Generation and detection of X-rays, X-ray diffraction methods (XRD), Determination of crystal structure, Lattice Parameter, Crystallite Size, Lattice Strain measurements, Williamson Hall Plot; Electron diffraction.	15
UNITII	Electron Microscopy and Surface Analysis: Interaction of electrons with solids, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning transmission electron microscopy (STEM), Scanning Probe Microscope (SPM): Atomic force microscopy (AFM), scanning tunneling microscopy (STM).	15
UNITIII	Optical and Thermal Characterization: Optical Microscopy, UV/Visible spectroscopy, Fourier Transform Infrared spectroscopy (FTIR), Atomic absorption spectroscopy (AAS), Raman spectroscopy. Thermo gravimetric analysis (TGA), Differential thermal analysis (DTA), DifferentialScanning Calorimetry (DSC).	15
UNITIV	Magnetic Characterization: Spectroscopy Techniques: Basic of nuclear magnetic resonance (NMR) and electron spin resonance (ESR) spectroscopy, Magnetic Measurements: Vibrating Sample Magnetometer (VSM), Superconducting Quantum Interference Device (SQUID), Magnetic Force Microscopy, Mössbauer Spectroscopy.	15

Suggested Readings	
1. Poole C.P., Owens Jr. Frank J., Introduction to Nanotechnology, Wiley India Pvt. Ltd.	
2. Kulkarni S.K., Nanotechnology: Principles & Practices, Capital Publishing Company.	
3. Chattopadhyay K.K. and Banerjee A. N., Introduction to Nanoscience and Technology, PHI Learning Private Limited.	
4. Booker R., Boysen E., Nanotechnology, John Wiley and Sons.	
5. Hosokawa M., Nogi K., Naita M., Yokoyama T., Nanoparticle Technology Handbook, Elsevier, 2007.	
6. Bhushan B., Springer Handbook of Nanotechnology, Springer-Verlag, Berlin, 2004.	

Can be opted by	
Bachelor in Science with Physics as major subject	
Suggested Continuous Evaluation Methods:	
Course Prerequisites Passed Semester VIII with Physics as major	
Suggested Equivalent Online Courses: 13. MIT Open Learning- Massachusetts Institute of Technology, https://openlearning.mit.edu/ 14. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd 15. Swayam Prabha -DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8	





MASTER IN PHYSICS			
Programme: MASTER IN PHYSICS		YEAR V	SEMESTER X PRACTICAL
Subject: Physics			
Course code	Course Title: PRACTICAL		
Course Outcomes: The student will have adequate knowledge to perform the experiments of different fields of physics with clear understanding of the theory behind the experiment. Student will know about advanced experiments based on their specialization paper.			
Credits: 4			Core Compulsory
Max. Marks: 100 External Exam: 75 Internal assessment: 25			Min. Passing Marks: 36
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			
UNIT	TOPIC	No. of Lectures	
	List of Experiments: (a) Advanced Electronics 1.Study of regulated power supply (723). 2. Study of operational amplifier (741). 3. Study of Timer (555). 4. A to D and D to A converter 5. 1 of 16 Decoder/Encoder 6. Study of Multiplexer/Demultiplexer 7. Study of Logic gates (Different types) 8. Study of Comparator and Decoder 9. Study of amplitude and frequency modulations and demodulations. 10. Study of different flip- flop circuits (RS, JK, Dk type, T-type, Master slave). 11. Study of Digital combinational and sequential circuits 12. Study of Microprocessor (8085) 13. Study of SCR, DIAC, TRIAC 14. Study of IC- Based Power supply 15. Microwave experiment. 16. Shift Registers 17. Fiber Optics communication	60	
	List of Experiments: (b) Astrophysics 1. Study of Hubble's law (from given data) 2. Study of constant density neutron star 3. Study of the static parameters of a Neutron Star model with inverse square density distribution 4. Study of star cluster from a given data 5. Study of Extinction coefficients 6. Study of variability of stars	60	

	List of Experiments: (c) High Energy Physics 1. Characteristic curve of a GM Detector and verification of inverse square law. 2. Characteristic curve of a GM Detector and Absorption coefficient of a using aluminum GM Detector. 3. Energy spectrum of gamma rays using gamma ray spectrometer. 4. Absorption coefficient of aluminum using gama-ray spectrometer. 5. Characteristics of Scintillation Detector. 6. Study of gama-gama unperturbed angular correlations. 7. Study of particle tracks using a Nuclear Emulsion Detector. 8. Classification of tracks in interaction with Nuclear Emulsion and determination of excitation energy.	60
	List of Experiments: (d) Spectroscopy 1. Study of the vibrational levels of Iodine. 2. Measurement of the fluorescence spectra of Uranyl Nitrate Hexahydrate. 3. Determination of the intrinsic life time for a dye molecule. 4. Determination of change in dipole moment in excited state using Solvatochromic shift method. 5. Measurement of non radiative decay rate for a known sample. 6. Determination of the quantum yield of known samples using steady state spectroscopy.	60
	List of Experiments: (e) Condensed Matter Physics 1. To determine the crystallite size of a nanomaterial using Debye Scherrer method 2. To determine the band gap energy of a material 3. To undersatand the microstructural features of ceramics 4. Study and analysis of FTIR spectra 5. To study I-V characteristics of a semiconductor 6. To study the surface morphology of a material be SEM 7. Synthesis of nanoparticle using sol-gel method 8. Determination of lattice parameters using XRD technique	60
Can be opted by Bachelor in Science with Physics as major subject		
Suggested Continuous Evaluation Methods:		
Course Prerequisites Bachelor in Science with Physics as major subject		
Suggested Equivalent Online Courses: 1. Virtual Labs at Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=1&brch=74 2. Digital Platforms /Web Links of other virtual labs may be suggested / added to this lists by individual Universities		