जम्मू केंद्रीय विश्वविद्यालय
Central University of Jammu
राया – सूचानी; बागला, जिला सांबा – 181143 जम्मू, जम्मू एवं कश्मीर
Rahya – Suchani (Bagla), DistrictSamba – 181143, Jammu (J&K)

No.CUJ/Acad/Phy/2021/153

30 March, 2021

NOTIFICATION No. 31 /2021

Sub: Course Scheme and Syllabus of **3rd** and **4th Semesters** of **Integrated B.Sc. (Hons.) – M.Sc. Course** in **Physics** w.e.f. Academic Session **2020 – 21** – Reg.

Ref: Notification No. 68 of 2018 dated 02.11.2018

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It is hereby notified for the information of all concerned that on the recommendation of the Board of Studies of Department of Physics and Astronomical Sciences and Dean, School of Basic & Applied Sciences, the Vice Chancellor in anticipation of Academic Council has approved the following **Course Scheme** and **Syllabus** of **3rd** and **4th semesters** of **Integrated B.Sc. (Hons.) – M.Sc. Course** in **Physics** w.e.f. Academic Session **2020 – 21**.

Semester 3rd

Course Code	Course Title	Credit	CIA	MSE	ESE	Max Marks
Core Courses						
ICPHY3C003T	Mathematical Physics – II	4	25	25	50	100
ICPHY3C005L	Mathematical Physics – II Lab	2	12.5	12.5	25	50
ICPHY3C004T	Thermal Physics	4	25	25	50	100
ICPHY3C006L	Thermal Physics Lab	2	12.5	12.5	25	50
ICPHY3C005T	Analog Systems and Applications	4	25	25	50	100
ICPHY3C007L	Analog Electronics Lab	2	12.5	12.5	25	50
Elective Course						
ICPHY3E002T	Astronomy and Astrophysics	4	25	25	50	100
ICPHY3E001L	Astronomy and Astrophysics Lab	2	12.5	12.5	25	50
Foundation Course						
ICPHY3F001T	Renewable Energy and Energy Harvesting	2	12.5	12.5	25	50
Total		**26**	-	-	-	**650**

Semester 4th

Course Code	Course Title	Credit	CIA	MSE	ESE	Max Marks
Core Courses						
ICPHY4C005T	Mathematical Physics – III	4	25	25	50	100
ICPHY4C006L	Mathematical Physics – III Lab	2	12.5	12.5	25	50
ICPHY4C006T	Elements of Modern Physics	4	25	25	50	100
ICPHY4C007L	Modern Physics Lab	2	12.5	12.5	25	50
ICPHY4C007T	Digital Systems and Applications	4	25	25	50	100
ICPHY4C008L	Digital Electronics Lab	2	12.5	12.5	25	50
Elective Course						
ICPHY4E001T	Atomic and Molecular Physics	4	25	25	50	100
ICPHY4E002T	Atomic and Molecular Physics Lab	2	12.5	12.5	25	50
Foundation Course						
ICPHY4F001T	Basics of Computer Programming	2	12.5	12.5	25	50
Total		**26**	-	-	-	**650**

(Dr. Ravi Kumar)
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Encl: Syllabus of 3rd and 4th Semester

To: Head, Department of Physics and Astronomical Sciences

Copy to: Controller of Examinations

Int. B.Sc(H)-M.Sc. Physics			
Semester :	III	**Type:**	Core
Course Name:	Mathematical Physics-II	**Course Code:**	ICPHY3C003T
Credits:	4	**L T P:**	3-1-0

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

UNIT-I

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. **Partial Differential Equations**: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes.

UNIT-II

Special Functions and their properties: Frobenius method and its applications to differential equations: Legendre, Bessel, Hermite and Laguerre Differential Equations. Singular Points of Second Order Linear Differential Equations and their importance. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality, Simple recurrence relations. Properties of Bessel Functions of the First Kind and second kind: Generating Function, simple recurrence relations, Zeros of Bessel Functions and Orthogonality. Hermite and Laguerre Differential Equations and properties.

UNIT-III

Greens functions: Dirac delta functions-properties and representations, Definitions and physical significance of Greens functions, Greens function for ordinary differential operators, first order linear differential operators and second order linear differential operators. Greens functions for partial differential operators, Laplace diffusion equation and wave equation operators, solution of boundary value problems using greens function for Laplace, Poisson and wave equations.

UNIT-IV

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.

UNIT-V

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability integral). **Tensors:** definition and properties (inner and outer products, contraction)

Reference Books:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.

2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
4. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
5. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
6. Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

Int. B.Sc(H)-M.Sc. Physics			
Semester :	III	**Type:**	Core
Course Name:	Mathematical Physics-II Lab	**Course Code:**	ICPHY3C005L
Credits:	2	**L T P:**	0-0-4

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Topics	*Description with applications*
Introduction to Numerical computation software Scilab	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).
Curve fitting, Least square fit, Goodness of fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate spring constant
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Solution of ODE, First order Differential equation Euler, modified Euler and Runge-Kutta second order methods	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling

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Second order differential equation Fixed difference method	• Classical equations of motion Second order Differential Equation • Harmonic oscillator (no friction) • Damped Harmonic oscillator • Over damped • Critical damped • Oscillatory • Forced Harmonic oscillator • Transient and • Steady state solution • Apply above to LCR circuits also
Using Scicos / xcos	• Generating square wave, sine wave, saw tooth wave • Solution to harmonic oscillator • Study of beat phenomenon • Phase space plots

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
3. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan,
4. 1940, Jones & Bartlett.
5. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
6. Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
7. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
8. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	III	**Type:**	Core
Course Name:	THERMAL PHYSICS	**Course Code:**	ICPHY3C004T
Credits:	4	**L T P:**	3-1-0

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

Unit-I

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Unit-II

Second Law of Thermodynamics: Second law of thermodynamics, Carnot theorem, thermodynamic scale of temperature and its identify with gas scale, entropy changes in reversible and irreversible processes law of increase of entropy with examples, T-S diagram entropy and disorder . heat death of universe, impossible of attaining absolute zero, Nernst heat theorem and third law of thermodynamics, Adiabatic expansion, Joule-Thomson expansion , Boyle temperature ,temperature of inversion and Critical temperature of gas . principle of regenerative cooling and of cascade cooling.

Unit-III

Thermodynamic Potentials: Extensive and intensive thermodynamic variable, Maxwell's general relations. Applications to Joule-Thomson cooling, Clausius – Clapeyron latent heat equations, Thermodynamic potential and equilibrium of thermodynamics system, relation with thermodynamics variables, cooling due to adiabatic demagnetization productions and measurement of very low temperatures.

Unit-IV

Kinetic Theory of Gases: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification, Doppler Broadening of Spectral Lines and Stern's Experiment, Mean, RMS and Most Probable Speeds, Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

Unit-V

Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases.

Reference Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	III	**Type:**	Core
Course Name:	THERMAL PHYSICS LAB	**Course Code:**	1CPHY3C006L
Credits:	2	**L T P:**	0-0-4

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

THERMAL PHYSICS LAB PRACTICAL

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	III	**Type:**	Core
Course Name:	Analog Systems & Applications	**Course Code:**	ICPHY3C005T
Credits:	4	**L T P:**	3-1-0

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

UNIT-I

Semiconductor Diodes: P and N-type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode.

UNIT-II

Two-terminal Devices and their Applications: Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, Capacitor filter. Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.

UNIT-III

Bipolar Junction transistors (BJT): n-p-n and p-n-p Transistors. Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Characteristics of CB, CE and CC Configurations. Current gains and their Relations, Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cut-off and Saturation Regions. Field effect transistors (Basic principle of operations only). Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains.

UNIT-IV

Amplifiers and Oscillators: Classification of Class A, B & C Amplifiers. Frequency response of a CE amplifier. Coupled Amplifier: Two stage RC-coupled amplifier. Feedback in Amplifiers: effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators

UNIT-V

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. Applications of Op-Amps: Linear - (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7)

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Zero crossing detector (8) Wein bridge oscillator. Non-linear (1) inverting and non-inverting comparators, (2) Schmidt triggers. Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation),

Reference Books:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall. Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI.
3. Learning Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill.
4. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
5. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
6. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer.
7. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India.

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	III	**Type:**	Core
Course Name:	Analog Electronics Lab.	**Course Code:**	IC PHY 3C007L
Credits:	2	**L T P:**	0-0-4

The aim of this Lab is not just to teach electronics but to emphasize its role in solving problems in Physics.

List of Practical

1. To study the reverse characteristics of Zener diode and study the load and line regulation.
2. To study the static characteristics of BJT in CE Configuration.
3. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias
4. To study the frequency response of the BJT amplifier in CE mode.
5. To study the static characteristics of FET.
6. To study OPAMP - inverting amplifier, non inverting amplifier, adder, substractor, comparator, integrator, differentiator.
7. To design a Wien bridge oscillator for given frequency using an op-amp.

Reference Books

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
3. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson.

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Int. B. Sc(H)-M. Sc. Physics			
Semester :	III	**Type:**	AEEC
Course Name:	Renewable Energy and Energy Harvesting	**Course Code:**	ICPHY3E001T
Credits:	2	**L T P:**	2-0-0

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

UNIT-I

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy and their limitation, need of renewable energy, non-conventional energy sources. developments in offshore Wind Energy, Tidal Energy, Wave energy systems, biomass, biochemical conversion, biogas generation, tidal energy, Hydroelectricity.

UNIT-II

Solar energy: Solar energy and its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond, solar water heater, solar distillation, solar cooker, solar green houses, Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

UNIT-III

Wind Energy Harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

UNIT-IV

Ocean Energy, Geothermal Energy and Hydro Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. Geothermal Resources, Geothermal Technologies. Hydropower resources and technologies, environmental impact of hydro power sources.

UNIT-V

Piezoelectric Energy harvesting: Introduction and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.

Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi.Solar energy - M P Agarwal - S Chand and Co. Ltd.
2. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
3. Godfrey Boyle, Renewable Energy, Power for a sustainable future, 2004, Oxford University Press, in association with The Open University.
4. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009. J.Balfour, M.Shaw and S.Jarosek, Photovoltaics, Lawrence J Goodrich (USA)

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Five years Integrated M.Sc. Physics			
Semester :	IV	**Type:**	Generic Elective
Course Name:	Astronomy and Astrophysics	**Course Code:**	ICPHY3E002T
Credits:	4	**L T P:**	3-1-0

Unit-I

Observational Data: celestial sphere, geometry of the sphere, spherical Trigonometry, astronomical coordinates-equatorial, horizon, ecliptic and galactic systems of coordinates, conversion from one system of co-ordinates to another; perturbations of coordinates, constellations, sidereal time & solar time, astronomical time systems, calendars.

Unit-II

Telescopes & instrumentation: different optical configurations for astronomical telescopes, mountings, plate scale and diffraction limits.Telescopes for gamma ray, X-ray, UV, IR; radio astronomy, stellar photometry- solid state, photo-multiplier tube and CCD based photometers, spectroscopy and polarimetry using CCD detectors.

Unit-III

Photometric concepts: intensity, flux density, luminosity, magnitude scale- apparent and absolute magnitude, distance modulus; determination of mass, luminosity, radius, temperature and distance of a star, colour index; **Stellar classification:** Henry-Draper and modern M-K classification schemes, H-R diagram, empirical mass-luminosity relation.

Unit-IV

Stars: Ordinary stars, binary stars, variable stars, **Sun**: physical characteristics of sun-basic data, solar rotation, solar magnetic fields, photosphere- granulation, sunspots, Babcock model of sunspot formation, solar atmosphere-chromosphere and corona, **Variable stars:** classes of variable stars, pulsation mechanism, classical cepheids as distance indicators, **Compact Stars:** white dwarfs, neutron stars and black holes.

Unit-V

The Milky Way: Methods of Distance Measurement, Stellar Statistics, Structural Components of the Milky Way, The Rotation of the Milky Way, **Galaxies:** the Classification of Galaxies, the Big Bang theory, the origin and evolution of galaxies, **Cosmology:** cosmological observation & principle, Homogeneous and Isotropic Universes, history of the Universe, the Formation of Structure the future of the Universe.

Text Books and References:

1. M. Zeilik, Astronomy-The Evolving Universe, (Cambridge Univ. Press).
2. Morrison, Introduction to Astronomy & Cosmology, (Wiley).
3. C.R. Kitchin, Telescopes and Techniques, (Springer).
4. A.A. Henden& R.H. Kaitchuk, Astronomical Photometry, (William-Bell).
5. E. Budding, An Introduction to Astronomical Photometry, (Cambridge Univ. Press).
6. R.A. Freedman & W.J. Kaufmann, Universe (W.H. Freeman & Co).
7. H. Karttunen et al., Fundamental Astronomy, (Springer).
8. P.V. Foukal, Solar Astrophysics, (Wiley-VCH).
9. Bhatnagar & W.C. Livingston, Fundamentals of Solar Astronomy, (World Scientific).

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	III	**Type:**	Generic Elective
Course Name:	Astronomy and Astrophysics Lab	**Course Code:**	1CPHY3E001L
Credits:	2	**L T P:**	0-0-4

Objective

To create experiments for students studying an introductory course in astrophysics and astronomy.

List of Practical

1. To become familiar with the astronomical objects visible to naked eye in the night sky using the software Stellarium. You will create a night sky map at different times. In the map you will identify astronomical objects such as planets, stars, nebula, milky way etc. You will then correlate the objects in the map with the directly observable night sky with naked eye.
2. Becoming Familiar with Constellations
   a. To become familiar with the Constellations in the night sky using the software Stellarium. You will learn to identify the constellations at different times (10 PM and 12 midnight) in the night, follow the steps-
   b. Step 1: Start the software Stellarium. Generate the sky map at 10 PM showing the constellation names.
   c. Step 2: The controls and resolution should be set such that (i) the 'Ground' is on (ii) the names of planets are listed, (iii) the entire sky is visible in a single image, (iv) The cardinal points are set according to your own convenience.
   d. Step 3: Identify the different constellations visually on the virtual sky. Make a rough sketch of all the constellations on a piece of paper. The sketch should show the locations of all the prominent stars in each constellation with a line joining them to roughly show the shape of the constellation.
3. To study the solar spectrum and identify some of the prominent spectral lines in the spectrum. You will also use the spectra to compute the column density of Hydrogen and Calcium atoms in the Solar atmosphere.
4. To extract coordinates of a star assuming a telescope in equatorial mount. You will also learn the concept of sidereal time.
5. To measure the Proper Motion of Barnard's Star.
6. To Identify a Circumpolar Star.
7. To extract the orbital inclination of a planet with respect to orbital plane of earth.
8. To measure the distance to the moon using parallax method
9. To Determine the observer's location by means of the stars and their co-ordinates.

Note: 1. Stellarium: Stellarium is a free open source planetarium for your computer. It shows a realistic sky in 3D, just like what you see with the naked eye, binoculars or a telescope. One can Download **Stellarium**
http://va-iitk.vlabs.ac.in/?page=software

2. New experiments can be added as per availability at Satish Dhawan Centre for Space Sciences, CU Jammu

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Syllabus 4th Semester

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Int. B. Sc.(H)-M.Sc. Physics			
Semester :	IV	**Type:**	Core
Course Name:	Mathematical Physics-III	**Course Code:**	ICPHY4C005T
Credits:	4	**L T P:**	3-1-0

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

UNIT-I

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Simply and multiply connected region, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions

UNIT-II

Matrices, Addition and Multiplication of Matrices: Null Matrices. Diagonal, Scalar and Unit Matrices. Upper- Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Similar Matrices. Trace of a Matrix Eigen – values and Eigen vectors of a Matrix.

UNIT-III

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional wave and diffusion/heat flow equations. **UNIT-IV**

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

UNIT-V

Introduction to Probability: Definition, Independent random variable: sample space and probability distribution functions. Binomial, Gaussian, and Poisson distribution with examples. Mean and variance.

Reference Books:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
4. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.

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5. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
6. Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	IV	**Type:**	Core
Course Name:	Mathematical Physics-III Lab	**Course Code:**	ICPHY4C006L
Credits:	2	**L T P:**	0-0-4

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:
   $dy/dx = e^{-x}$ with $y = 0$ for $x = 0$
   $dy/dx + e^{-x}y = x^2$
   $d^2y/dt^2 + 2\,dy/dt = -y$
   $d^2y/dt^2 + e^{-t}dy/dt = -y$
2. Dirac Delta function:
   $\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{\frac{-(x-2)^2}{2\sigma^2}} (x+3)dx$, for $\sigma = 1, 0.1, 0.01$ and show it tend to 5.
3. Fourier Series: Program to sum $\sum_{n=1}^{\infty}(0.2)^n$, evaluate the Fourier coefficients of a given periodic function (square wave)
4. Frobenius method and Special functions:
   $\int_{-1}^{+1} P_n(\mu)P_m(\mu)d\mu = \delta_{n,m}, Plot P_n(x), j_\vartheta(x)$
   Show recursion relation.
5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).
6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.
7. Evaluation of trigonometric functions e.g. $sin\,\theta$, Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.
8. Integral transform: FFT of e^{-x^2}

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
4. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
5. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
6. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	IV	**Type:**	AEEC
Course Name:	Basic of Computer Programming	**Course Code:**	ICPHY4F001T
Credits:	2	**L T P:**	2-0-0

Unit I

Operating Systems, types of operating systems; introduction to programming (C++/fortran-95 programming languages): Number Systems, Computer Codes, Computer Arithmetic.

Unit II

Basic idea of compilers; data and statements: data types, constants and variables; mathematical, relational, logical and bitwise operators; precedence of operators, expressions and statements, local and global variables; auto, static and external variables.Control statements: if-statement, if-else statement, nested-if structure, else-if statement; goto statement, switch statement; unconditional and conditional looping, while loop, do-while loop, for loop, break and continue statements, nested loops.

Unit III

Arrays and structures: one- and two-dimensional arrays, functions, function prototypes, function call by value and by references, idea of function overloading, Structures, Recursion.

Unit IV

Brief idea of classes, objects and inheritance: classes and objects; member functions in a class; idea of Strings and Pointers.

Unit V

Programs: roots of a quadratic equation, Calculate the factorial of number using recursion and normal method, fitting a straight line to a data, deviations about an average, arrange a List of numbers in ascending and descending order binary search.

Text Books and References:

1. Schaum's Outline of Programming with C++, John R. Hubbard, McGraw-Hill.
2. Numerical Recipes in C++: The Art of Scientific Computing, Teukolsky, Vetterling and Flannery, (Cambridge University Press).

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	IV	**Type:**	Core
Course Name:	ELEMENTS OF MODERN PHYSICS	**Course Code:**	IC PHYU0067
Credits:	4	**L T P:**	3-1-0

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

Unit-I

Theory of Relativity-I

Introduction to Frames of Reference; inertial and non- inertial, Gallian Transformation, Gallian Invariance of Newton's law, Laws of conservation of Linear momentum and Energy, Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Twin Paradox, Basic idea of General theory of relativity.

Unit-II

Theory of Relativity-II

Relativistic momentum and relativistic form of Newton's law, Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector, Minkowski space

Unit-III

Quantum theory of Light

Hertz's Experiment, Black Body radiation, ultraviolet catastrophe, Stefan's law, Rayleigh Jean's Law and Planck's Law, Light quantisation and the photoelectric effect, Compton effect, X-rays: Production and properties, de-Broglie wavelength and matter waves; Davisson-Germer experiment.

Unit-IV

Wave-particle duality. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Wavefunction and its significance, probability interpretation: Normalized wave functions as probability amplitudes, Heisenberg uncertainty principle (Statement with illustration and examples).

Unit-V

Optical Fibre: Optical fibre and its types, Critical angle of propagation, modes of propagation, Acceptance angles, Numerical aperture, Pulse dispersion, Attenuation and its various mechanism, Advantages and applications of optical fibres.

Lasers: Interaction of light with matter, (absorption, spontaneous, Einstein's prediction, stimulated emission), Einstein's relations, Light amplification, Population inversion, Pumping, Principal pumping schemes (three and four levels) Optical resonant cavity, conditions for laser action, Types of lasers (Ruby, He- Ne and semiconductor), Characteristics and applications of laser.

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill.

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3. Modern Physics, 3rd Ed., R A Serway, C. J. Moses, C. A. Moyer, 2005, Cengage Lerning.
4. Modern Physics, 3rd Ed., Randy Harris, 2018 , Pearson Learning India.

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	IV	**Type:**	Core
Course Name:	MODERN PHYSICS LAB	**Course Code:**	ICPHY4C007L
Credits:	2	**L T P:**	0-0-4

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

List of experiments:

1. Measurement of Planck's constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	IV	**Type:**	Core
Course Name:	DIGITAL SYSTEMS AND APPLICATIONS	**Course Code:**	ICPHY4C007T
Credits:	4	**L T P:**	3-1-0

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

Unit-I

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (i) Study of Waveform, (ii)Measurement of Voltage, Current, Frequency, and Phase Difference. **Integrated Circuits** (Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs.

Unit-II

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity. **Boolean algebra:** De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Min-terms and Max-terms. Conversion of a Truth table into Equivalent Logic Circuit by (i) Sum of Products Method and (ii) Karnaugh Map.

Unit-III

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **Arithmetic Circuits:** Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. **Sequential Circuits:** SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.

Unit-IV

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator **Shift registers:** Serial-in-Serial-out, Serial-in-Parallel-out, **Counters(4 bits):** Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

Unit-V

Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. **Intel 8085 Microprocessor Architecture:** Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI.

Reference Books:

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
5. Logic circuit design, Shimon P. Vingron, 2012, Springer.

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	IV	**Type:**	Core
Course Name:	DIGITAL ELECTRONICS LAB	**Course Code:**	1C PHYL0008L
Credits:	2	**L T P:**	0-0-4

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

List of Experiments:

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. Write the following programs using 8085 Microprocessor
    a) Addition and subtraction of numbers using direct addressing mode
    b) Addition and subtraction of numbers using indirect addressing mode
    c) Multiplication by repeated addition.
    d) Division by repeated subtraction.
    e) Handling of 16-bit Numbers.
    f) Use of CALL and RETURN Instruction.
    g) Block data handling.
    h) Other programs (e.g. Parity Check, using interrupts, etc.).

Reference Books:

1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
3. Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
4. Microprocessor 8085:Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

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Int. B.Sc(H)-M.Sc. Physics			
Semester :	IV	**Type:**	Generic Elective
Course Name:	ATOMIC AND MOLECULAR PHYSICS	**Course Code:**	ICPHY4E001T
Credits:	4	**L T P:**	3-1-0

(The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.)

UNIT-I

Atomic Spectra: Inadequacy of Bohr atomic model, correction due to finite mass of the nucleus, Rydberg constant in terms of reduced mass, Excitation and Ionisation potentials, Franck-Hertz experiment, Bohr-Sommerfeld Model of atom, vector model of an atom, Electron spin, space quantisation, magnetic moment of an electron due to its orbital motion. Stern-Gerlach experiment and its theory, Spin-orbit interaction and Fine structure of spectral lines

UNIT-II

One- and two-valence electron systems: Quantum numbers and selection rules, Pauli's exclusion principle, Electronic configuration of atoms, Pauli Exclusion principle and electron configuration, quantum states, Spectral notations of quantum states. Spin-Orbit Interaction (Single valence electron atom), Energy levels of Na atom, selection rules, sodium Doublet. **Two-valence electron systems:** Spectral terms of two electron atoms, terms for equivalent electrons, LS and JJ coupling schemes. Singlet Triplet separation for interaction energy of LS coupling. Lande's Interval rule, Problems.

UNIT-III

Zeeman Effect : Early discoveries and developments, Experimental arrangement, Normal and anomalous Zeeman Effect Problems, Stark effect (Qualitative discussion), **X-ray spectroscopy:** Nature of X-rays, Discrete and continuous X-ray spectra, Daune and Hunt's Rule, X-ray emission spectra, Mosley's law and its applications, Auger effect , Problems

UNIT-IV

Molecular Spectra: Molecular formation, the H molecular ion, H_2 – molecule. Salient features of molecular spectra. Rotation, vibration and electronic spectra of molecules, associated quantum numbers and selection rules, Theory of pure rotation and rotation- vibration spectra, Raman and IR spectra, simple applications.

UNIT-V

Raman spectroscopy: Classical theory of Raman Effect. Molecular polarizability, Quantum theory of Raman Effect, Experimental set up for Raman Effect, Applications of Raman spectroscopy

Books Recommended:

1. Atomic Physics (Modern Physics), S N Ghosal, (S. Chand)
2. Concepts of Modern Physics 4th edition, Arthur Baiser (McGraw Hill International edition)
3. Introduction to Atomic spectra, H. E White. (McGraw Hill International edition)
4. Introduction to Atomic and Molecular Spectroscopy , V.K.Jain, Narosa Publication.

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