SEMESTER 1 (HONS)

Core P1 – Mathematical Physics Lab **TEACHER: DB & SS**

Mathematical Physics	
60 class hours	**2 credits**

General Topics

Computer architecture and organization, memory and Input/output devices.

Basics of scientific computing: Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.

Errors and error Analysis: Truncation and round off errors, Absolute and relative errors, Floating point computations.

Introduction to plotting graphs with QtiPlot (or equivalent)

Basic 2D and 3D graph plotting - plotting functions and datafiles, fitting data using qtiplot's fit function, polar and parametric plots, modifying the appearance of graphs, Surface and contour plots, exporting plots.

Introduction to programming in python:

- Python as a number calculator
- algebraic calculation through python interactively
- help searching
- standard I/O statements
- program with formula crunching
- string, list, tuple and the corresponding methods

- Control structures

Programs as applications

- finite series summation
- Taylor series summation with a given precision

File handling in Python

- File I/O statements

Least square fitting

- Linear and linearised Least square fitting with supplied data

User defined functions in Python

- User defined function, default argument.

synthetic data generation and plotting

- synthetic data generation and plotting with QtiPlot (or equivalent).

Finding largest and smallest values within a dataset

- Finding largest and smallest values over a time-series data.
- Estimating largest and smallest values of a function within an interval using fixed step size.

Solution of Algebraic and Transcendental equations

- Root finding: Bisection & New Raphson Method (Initial guess to be determined by plotting) for non-linear equations.
- Applications in simple physical problems (including those of mathematical Physics)

Core P2 – Mechanics Lab

TEACHER: TM & TS

Mechanics	
60 class hours	**2 Credits**

General Topic

Discussion on random errors in observations. Measurement principles of length (or diameter) using vernier caliper, screw gauge and travelling microscope. Discussion on the parts of Sextant.

List of Practical

1. To study the random error in observations of time period of some oscillation using chronometer.
2. To determine the Moment of Inertia of a regular body using another auxilary body and a cradle suspeded by a metalic wire.
3. To determine g and velocity for a freely falling body using Digital Timing Technique
4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
5. To determine the Young's Modulus by flexure method.
6. To determine the Modulus of Rigidity of a Wire by a torsional pendulum.
7. To determine the height of a building using a Sextant.
8. To determine the elastic Constants of a wire by Searle's method.
9. To determine the value of g using Bar Pendulum.
10. To determine the value of g using Kater's Pendulum.
11. To study the Motion of Spring and calculate, (a) Spring constant, (b) g and (c) Modulus of rigidity.

SEMESTER III (HONS)

Core P5 – Mathematical Physics II Lab **TEACHER: SS & DB**

60 class hours	**2 Credits**
General Topics: Introduction to the python numpy module. Arrays in numpy, array operations, array item selection, slicing, shaping arrays. Introduction to online graph plotting using matplotlib. Use scipy to generate Legendre Polynomials and Bessel function and then plot those using matplotlib.Detailed discussion on the underlying theory of the following numerical methods including efficiency of the method in each case. Simple physical problems based on these methods are to be introduced.	
Sorting:	
1.bubble sort 2. insertion sort	
Statistical Calculations :	
• mean, median and standard deviation for a set of discrete data points	
Interpolation:	
• Newton-Gregory forward & backward formula	
Numerical differentiation	
• Forward and Backward difference formula	
Numerical Integration	
• By trapezoidal rule. • By Simpson's 1/3 rd rule.Integration by stochastic method	
Integration by stochastic method	
• Monte Carlo random dot method	
Solution of ODE First order Differential equation	
• Euler Method	

Core P6 – Thermal Physics Lab **TEACHER: SS & SC**

60 class hours	**2 Credits**
General Topics: Discussion on logs cale plot to study power law dependence, decay constant etc. Discussion on the properties of PRT, thermocouple, diode sensor etc.	
List of Practical	

1. Verification of Stefan's law using a torch bulb.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT) using constant current source
4. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
5. To calibrate a thermocouple to measure temperature in a specified Range by Null Method using a potentiometer.
6. To calibrate a thermocouple to measure temperature in a specified Range by direct measurement using Op-Amp differential amplifier and to determine Neutral Temperature
7. Mesuring unknown temperature using a diode sensor.
8. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
9. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
10. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

Core P7 – Digital Systems and Applications Lab **TEACHER: TS & RM**

60 class hours	**2 Credits**

1) In the Beginning of practical course a *brief history of development of electronics* should be introduced.
2) In continuation of the previous topic, physically introduce the Valve, Transformer, Resistance, Capacitor, Potentiometer etc. and also Impotant measuring instruments (viz. digital & analog multimeter, power supply, function generator, Oscilloscope) to be used in the following experiments. Describe their characteristics with an explanation of their working principle).
3) In rest of the all practical classes: Approximately 25% of the class period should be used in introducing the perspectives and importance of the experiments to be done; details of the experiments and discussion on the observations of last class.1. a) To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.

List of Practical

1. a) To measure (i) Voltage, and (ii) Time period of a periodic waveform using CRO.

   b) To test a Diode and Transistor using a Multimeter.

2. a) To design a switch (NOT gate) using a transistor.

   b) To verify and design AND, OR, NOT and XOR gates using NAND gates.

3. For a given truth table find logic equation, minimize and design the circuit using logic gate ICs.
4. Half Adder, Full Adder and 4-bit binary Adder.
5. To build Flip-Flop (RS, D-type and JK) circuits using NAND gates.
6. To design an astable multivibrator of given specifications using 555 Timer.
7. To design a monostable multivibrator of given specifications using 555 Timer.
8. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
9. To build JK Master-slave flip-flop using Flip-Flop ICs
10. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
11. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.

SEMESTER V(HONS)

Core P11 – Quantum Mechanics and Applications Lab **TEACHER: DB & SS**

General Topics: Detailed discussion on the underlying theory of the following numerical methods including efficiency of the method in each case.

List of Practical

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

   Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is □ □-13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511×10^6 eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

   where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

   Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $(eVÅ)^{1/2}$, m = 0.511x106 eV/c2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

   For the anharmonic oscillator potential

   for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3} In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

   Where μ □ □ is the reduced mass of the two-atom system for the Morse potential

   Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of

   three significant digits. Also plot the corresponding wave function. Take: m = 940x106eV/C^2, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

Core P12 – Solid State Physics Lab **TEACHER: DB & SC**

60 class hours	**2 Credits**
General Topics: Discussion on the operation of the relevant circuits used for the different studies in the following experiments.	
List of Practical	

1. To determine the Coupling Coefficient of a Piezoelectric crystal.
2. To measure the Dielectric Constant of a dielectric Materials with frequency
3. To study the characteristics of a Ferroelectric Crystal.
4. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
5. To measure the resistivity of a semiconductor (Ge) with temperature by reverse bias characteristics of Ge diode (room temperature to 80 oC) and to determine its band gap.
6. To determine the Hall coefficient of a semiconductor sample.
7. To study temperature coefficient of a semiconductor (NTC thermistor)
8. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
9. To measure the Magnetic susceptibility of Solids.
10. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
11. To determine the refractive index of a dielectric layer using SPR

PHYSICS GENERAL

SEM I (GEN)

GE P1 – Mechanics Lab **TEACHER: SC & RM**

60 class hours	**2 Credits**

General Topic

Discussion on random errors in observations. Measurement principles of length (or diameter) using vernier caliper, screw gauge and travelling microscope. Discussion on the parts of Sextant.

List of Practical

1. To study the random error in observations of time period of some oscillation using chronometer.
2. To determine the Moment of Inertia of a regular body using another auxilary body and a cradle suspeded by a metalic wire.
3. To determine g and velocity for a freely falling body using Digital Timing Technique
4. To determine the Young's Modulus by flexure method.
5. To determine the Modulus of Rigidity of a Wire by a torsional pendulum.
6. To determine the height of a building using a Sextant.
7. To determine the elastic Constants of a wire by Searle’s method.
8. To determine the value of g using Bar Pendulum.
9. To determine the value of g using Kater’s Pendulum.
10. To study the Motion of Spring and calculate, (a) Spring constant, (b) g and (c) Modulus of rigidity.

SEMESTER III (G)

GE P3 – Thermal Physics and Statistical Lab   TEACHER: TM & TS

60 class hours	2 Credits
List of Practical	

1. Verification of Stefan's law using a torch bulb.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).using constant current source
4. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
5. To calibrate a thermocouple to measure temperature in a specified Range by Null Method using a potentiometer.
6. To calibrate a thermocouple to measure temperature in a specified Range by direct measurement using Op-Amp differential amplifier and to determine Neutral Temperature
7. Measurement of unknown temperature using Diode sensor.
8. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
9. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
10. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

GE P5 – Digital, Analog Circuits and Instruments Lab **TEACHER: RM & TM**

60 class hours	**2 Credits**
List of Practical	

1. To measure (a) Voltage, and (b) Frequency of a periodic waveform using CRO
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To minimize a given logic circuit.
4. Half adder, Full adder and 4-bit Binary Adder.
5. Adder-Subtractor using Full Adder I.C.
6. To design an astable multivibrator of given specifications using 555 Timer.
7. To design a monostable multivibrator of given specifications using 555 Timer.
8. To study IV characteristics of PN diode, Zener and Light emitting diode
9. To study the characteristics of a Transistor in CE configuration.
10. To design a CE amplifier of given gain (mid-gain) using voltage divider bias.
11. To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.
12. To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
13. To study Differential Amplifier of given I/O specification using Op-amp.
14. To investigate a differentiator made using op-amp.
15. To design a Wien Bridge Oscillator using an op-amp.