University of Mumbai

No. AAMS_UGS/ICC/2023-24/78

CIRCULAR:-

Sub: - M.Sc. (Physics) (Sem. I & II).
Ref: - No. AAMS_UGS/ICC/2023-24/63 dated 23rd November, 2023.

All the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head University Departments in Faculty of Science & Technology are hereby informed that the Board of Deans at its meeting held on 22nd November, 2023 **vide** item No. 6.4 (A) have been accepted by the Academic Council at its meeting held on 24th November, 2023 **vide** item No. 6.4 (A) for the following Regulation no. R. SP-5A is amended for the M.Sc. (Physics) programs with reference to adding of Electives courses as per the appendix attached herewith.

Amendment of Regulation No. R. SP-5A for Credit Structure

Sr. No.	Regulation No. for Credit Structure	Program Name	Semester	Appendix
1	R. SP-5A	M.Sc. (Physics)	Sem. I & II	I

(The said circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
15th December, 2023

(Prof. Sunil Bhirud)
I/c. REGISTRAR

To,

The Principals of the Affiliated Colleges, Directors of the recognized Institutions and the Head University Departments in Faculty of Science & Technology.

A.C/6.4(A)/24/11/2023

Copy forwarded with Compliments for information to:-

1) The Chairman, Board of Deans,
2) The Dean, Faculty of Science & Technology,
3) The Chairman, Board of Studies,
4) The Director, Board of Examinations and Evaluation,
5) The Director, Department of Students Development,
6) The Director, Department of Information & Communication Technology,
7) The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,
8) The Co-ordinator, MKCL.

Copy forwarded for information and necessary action to :-	
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), dr@eligi.mu.ac.in
2	The Deputy Registrar, Result unit, Vidyanagari drresults@exam.mu.ac.in
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari cap.exam@mu.ac.in
6	The Deputy Registrar, College Affiliations & Development Department (CAD), deputyregistrar.uni@gmail.com
7	The Deputy Registrar, PRO, Fort, (Publication Section), Pro@mu.ac.in
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in ar.tau@fort.mu.ac.in
11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
12	The Deputy Registrars, Finance & Accounts Section, fort draccounts@fort.mu.ac.in
13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
14	The Assistant Registrar, Administrative Sub-Campus Thane, thanesubcampus@mu.ac.in
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentre@gmail.com

Copy for information :-	
1	P.A to Hon'ble Vice-Chancellor, vice-chancellor@mu.ac.in
2	P.A to Pro-Vice-Chancellor pvc@fort.mu.ac.in
3	P.A to Registrar, registrar@fort.mu.ac.in
4	P.A to all Deans of all Faculties
5	P.A to Finance & Account Officers, (F & A.O), camu@accounts.mu.ac.in

MSc (Physics) Sem 1 & 2

Syllabus for Non-Autonomous Colleges affiliated to University of Mumbai

Credit Distribution Structure for Two Years / One Year PG

Year	Level	Sem	Major		RM	OJT/FP	RP	Cum Cr	Degree
			Mandatory	Elective					
1	6.0	1	4x3+2x1=14	4	2+2=4	-	-	22	
			Classical Mechanics (501)	Elective 1 (505)	(506) (Theo+Pract)				
			Quantum Mechanics (502)						
			Mathematical Physics (503)						
			Practical - 1 (504)						
1	6.0	2	4x3+2x1=14	4	-	4	-	22	
			Introduction to Programming (511)	Elective 2 (515)		Field Project/ On Job Training (516) (College evaluation)			
			Applications of Quantum Mechanics: Nuclear Physics (512)						
			Electrodynamics (513)						
			Practical - 2 (514)						
Cum Cr for PG Diploma			28	8	4	4		44	

Exit Option 1 year PG Diploma (44 Credits) after Three Year UG Degree

Year	Level	Sem	Major		RM	OJT/FP	RP	Cum Cr	Degree
			Mandatory	Elective					
2	6.5	3	4x3+2x1=14	4	-	-	4	22	
			Nuclear Physics (601)	Elective 3 (605)			Research Project (606)		

			Electronics – 1 (602)						
			Statistical and Thermal Physics (603)						
			Practical - 3 (604)						
2	6.5	4	4x3+2x1=14	4	-	-	4	22	
			Experimental Physics (611)	Elective 4 (615)			Research Project (616)		
			Electronics – 2 (612)						
			Atomic and Molecular Physics (613)						
			Practical - 4 (614)						
Cum Cr for PG Diploma			28	8			8	44	

Exit Option 1 year PG Diploma (44 Credits) after Four Year UG Degree

Exit Option 2 year PG Diploma (88 Credits) after Three Year UG Degree

List of Electives

Elective 1	**Elective 2**	**Elective 3**	**Elective 4**
VLSI Design and Embedded System 1	VHDL, C++, Python Programming	Microwave Electronics	Microprocessor and Microcontroller
Biomedical Physics	VLSI Design and Embedded Systems 2	Python Programming	Python programming and Machine Learning
Signal Modulation and Transmission Techniques	Embedded C and Interfacing	Digital Communication Systems and Python Programming	Radar and Optical Fiber Communication
Fundamental of Material Science	Materials and their Applications	Energy Studies	Polymers
Solid State Devices	**Solid State Physics**	**VHDL, C++ Programming**	**Embedded C, ARM and Interfacing**
			Microwave Electronics, Radar and Optical Fiber Communication

Semester 1

Practical – 1 (504)

Group A

	Experiment		Reference Books
1	Michealson Interferometer		Advanced Practical Physics -Worsnop and Flint
2	Analysis of sodium spectrum	a	Atomic spectra- H.E. White
		b	Experiments in modern physics –Mellissinos
3	h/e by vacuum photocell	a	Advanced Practical Physics -Worsnop and Flint
		b	Experiments in modern physics- Mellissinos
4	Study of He-Ne laser measurement of wavelength using reflection grating	a	A course of experiments with Laser – Siroh
		b	Elementary experiments with LaserG. White
5	Coupled Oscillations		Coupled Oscillations HBCSE Selection camp 2007 Manual
6	Carrier lifetime by pulsed reverse method		Semiconductor electronics by Gibson
7	Temperature dependence of avalanche and Zener breakdown diodes	a	Solid state devices – W.D. Cooper
		b	Electronic text lab manual – PB Zbar
		c	Electronic devices & circuits – Millman and Halkias
8	Determination of particle size of lycopodium particles by laser diffraction method	a	A course of experiments with Laser – Siroh
		b	Elementary experiments with Laser- G. White
9	Microwave oscillator characteristics		Physics of Semiconductor Devices by S.M.Sze

Group B

	Experiments		References
1	Diac - Triac phase control circuit	a	Solid state devices- W.D. Cooper
		b	Electronic text lab manual - P.B. Zbar
2	Delayed linear sweep using 1C 555		Electronic Principles - A. P. Malvino
3	Regulated power supply using IC LM 317 voltage regulator IC	A	Operational amplifiers and linear Integrated circuits – Coughlin & Driscoll
		b	Practical analysis of electronic circuits through experimentation – L.MacDonald
4	Regulated dual power supply using IC LM317 and IC LM 337 voltage regulator Ics	a	Operational amplifiers and linear Integrated circuits – Coughlin & Driscol
		b	Practical analysis of electronic circuits through experimentation – L.MacDonald
5	Contant current source using IC 741 and LM 317		Integrated Circuits- K. R. Botkar
6	Active filter circuits (second order)	a	Op-amps and linear integrated circuit technology- R. Gayakwad
		b	Operational amplifiers and linear integrated circuits – Coughlin &. Driscol
7	Study of 4 digit multiplex display system		Digital Electronics - Roger Tokheim

5	Temperature on-off controller using IC		Op-amps and linear integrated circuit technology by Gayakwad
6	Waveform Generator using IC	a	Operational amplifiers and linear integrated circuits- — Coughlin & Driscoll
		b	Op-amps and linear integrated circuit technology: R. Gayakwad
		c	Operational amplifiers: experimental manual C.B. Clayton
7	Instrumentation amplifier and its application	a	Operational amplifiers and linear integrated circuits- — Coughlin & Driscoll
		b	Integrated Circuits – K. R. Botka
8	Study of 8-bit DAC	a	Op-amps and linear integrated circuit technology: R. Gayakwad
		b	Digital principles and applications by Malvino and Leach
9	16 channel digital multiplexer	a	Digital principles and applications by Malvino and Leach
		b	Digital circuit practice by RP Jain
10	Study of elementary digital voltmeter		Digital Electronics by Roger Tokheim (5th Ed, page 371)

Note: Minimum number of experiments to be performed and reported in the journal = 06 with minimum 3 experiments from each Group. i.e. Group A: 03 and Group B: 03

Additional references:

1. Digital theory and experimentation using integrated circuits - Morris E. Levine (Prentice Hall) Practical analysis of electronic circuits through experimentation - Lome Macronaid (Technical Education Press)
2. Logic design projects using standard integrated circuits - John F. Waker (John Wiley & sons) Practical applications circuits handbook - Anne Fischer Lent & Stan Miastkowski (Academic Press)
3. Digital logic design, a text lab manual - Anala Pandit (Nandu printers and publishers Pvt. Ltd.)

Elective – 1

Solid State Devices (515) (60 lectures, 4 credits)

Unit-I: Semiconductor Physics:

Classification of Semiconductors; Crystal structure with examples of Si, Ge & GaAs semiconductors; Energy band structure of Si, Ge & GaAs; Extrinsic and compensated Semiconductors; Temperature dependence of Fermi-energy and carrier concentration. Drift, diffusion and injection of carriers; Carrier generation and recombination processes- Direct recombination, Indirect recombination, Surface recombination, Auger recombination; Applications of continuity equation-Steady state injection from one side, Minority carriers at surface, Haynes Shockley experiment, High field effects. Hall Effect; Four – point probe resistivity measurement; Carrier life time measurement by light pulse technique. (SMS)

Unit-II: Semiconductor Devices I:

p-n junction : Fabrication of p-n junction by diffusion and ion-implantation; Abrupt and linearly graded junctions; Thermal equilibrium conditions; Depletion regions; Depletion capacitance, Capacitance – voltage (C-V) characteristics, Evaluation of impurity distribution, Varactor; Ideal and Practical Current-voltage (I-V) characteristics; Tunneling and avalanche reverse junction break down mechanisms; Minority carrier storage, diffusion capacitance, transient behavior; Ideality factor and carrier concentration measurements; Carrier life time measurement by reverse recovery of junction diode;; pi-n diode; Tunnel diode, Introduction to p-n junction solar cell and semiconductor laser diode. (SMS)

Unit-III: Semiconductor Devices II:

Metal – Semiconductor Contacts: Schottky barrier – Energy band relation, Capacitancevoltage (C-V) characteristics, Current-voltage (I-V) characteristics; Ideality factor, Barrier height and carrier concentration measurements; Ohmic contacts. Bipolar Junction Transistor (BJT): Static Characteristics; Frequency Response and Switching. Semiconductor heterojunctions, Heterojunction bipolar transistors, Quantum well structures. (SMS)

Unit-IV: Semiconductor Devices III:

Metal-semiconductor field effect transistor (MESFET)- Device structure, Principles of operation, Current voltage (I-V) characteristics, High frequency performance. Modulation doped field effect transistor (MODFET); Introduction to ideal MOS device; MOSFET fundamentals, Measurement of mobility, channel conductance etc. from Ids vs, Vds and Ids vs Vg characteristics. Introduction to Integrated circuits. (SMS)

Reference:

1. S.M. Sze; Semiconductor Devices: Physics and Technology, 2nd edition, John Wiley, New York, 2002.
2. B.G. Streetman and S. Benerjee; Solid State Electronic Devices, 5th edition, Prentice Hall of India, NJ, 2000.
3. W.R. Runyan; Semiconductor Measurements and Instrumentation, McGraw Hill, Tokyo, 1975.
4. Adir Bar-Lev: Semiconductors and Electronic devices, 2nd edition, Prentice Hall, Englewood Cliffs, N.J., 1984.
5. Jasprit Singh; Semiconductor Devices: Basic Principles, John Wiley, New York, 2001.
6. Donald A. Neamen; Semiconductor Physics and Devices: Basic Principles, 3rd edition, Tata McGraw-Hill, New Delhi, 2002.
7. M. Shur; Physics of Semiconductor Devices, Prentice Hall of India, New Delhi, 1995.
8. Pallab Bhattacharya; Semiconductor Optoelectronic Devices, Prentice Hall of India, New Delhi, 1995.
9. S.M. Sze; Physics of Semiconductor Devices, 2nd edition, Wiley Eastern Ltd., New Delhi, 1985.

Research Methodology – Theory (506) (30 Lectures, 2 Credits)

UNIT-1: Introduction to Research Methodology:

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific

Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India Defining the Research Problem: What is a Research Problem? , Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. (CRK)

UNIT-2: Interpretation, Report Writing & Techniques

Meaning of Interpretation, Why Interpretation?, Technique of Interpretation: Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, use of tools/techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, and Software for detection of Plagiarism. (CRK)

Reference: (Unit 1 & 2)

1. Research Methodology – C.R.Kothari

2. Best, J. W. and Khan, J. Research in Education. (7th Ed.) New Delhi: Prentice-Hall India Ltd. 1997.

3. Borg, B. L. Qualitative Research Methods. Boston: Pearson. 2004. 23

4. Bogdan, R. C. and Biklen, S. K. Qualitative Research For Education: An Introduction to Theory and Methods. Boston, MA: Allyn and Bacon.1998.

5. Bryman, A. Quantity and Quality in Social Science Research. London: Routledge.1988.

Research Methodology – Practical (506) (2 Credits)

Group A:

1	Susceptibility measurement by Quincke's method /Guoy's balance method		Advance practical physics – Worsnop and Flint
2	Absorption spectrum of specific liquids		Advance practical physics -Worsnop and Flint
3	Resistivity by four probe method		Semiconductor measurements by Runyan
4	DC Hall effect	a	Manual of experimental physics – E.V.Smith
		b	Semiconductor measurements by Runyan
		c	Semiconductors and solid state physics – Mackelvy
		d	Handbook of semiconductors – Hunter
5	Magneto resistance of Bi specimen		Semiconductor measurements by Runyan
6	Determination of Sheet Resistance		

Group B:

1	Characteristics of a Geiger Muller counter and measurement of dead time	a	Experiments in modern physics – Mellissinos
		b	Manual of experimental physics –EV-Smith

		c	Experimental physics for students – Whittle &. Yarwood
2	I-V/ C-V measurement on semiconductor specimen		Semiconductor measurements – Runyan
3	Measurement of dielectric constant, Curie temperature and verification of Curie— Weiss law for ferroelectric material	a	Electronic instrumentation & measurement: W. D. Cooper
		b	Introduction to solid state physics – C. Kittel
		c	Solid state physics — A. J. Dekkar
4	Energy Band gap by four probe method		Semiconductor measurements — Runyan
5	Measurement of dielectric constant (Capacitance)	a	Electronic instrumentation & measurement - W. D. Cooper
		b	Introduction to solid state physics - C. Kittel
6	Determination of ideality factor of diodes (at least two different diodes)		Solid State Devices – S M Sze

Note: Minimum number of experiments to be performed and reported in the journal = 06 with minimum 3 experiments from each Group. i.e. Group A: 03 and Group B: 03

Practical – 2 (514)

Group A

	Experiment		**References**
1	Zeeman Effect using Fabry-Perot etalon /Lummer — Gehrecke plate	a	Advance practical physics - Worsnop and Flint
		b	Experiments in modern physics - Mellissinos
2	Ultrasonic Interferometry-Velocity measurements in different Fluids		Medical Electronics- Khandpur
3	Measurement of Refractive Index of Liquids using Laser		Sirohi-A course of experiments with He-Ne Laser; Wiley Eastern Ltd
4	I-V/ C-V measurement on semiconductor specimen		Semiconductor measurements - Runyan
5	Double slit- Fraunhofer diffraction (missing order etc.)		Advance practical physics - Worsnop and Flint
6	Determination of Young's modulus of metal rod by interference method		Advance practical physics - Worsnop and Flint (page 338)
7	Carrier mobility by conductivity		Semiconductor electronics - Gibson
8	Measurement of dielectric constant, Curie temperature and verification of Curie— Weiss law for ferroelectric material	a	Electronic instrumentation & measurement: W. D. Cooper
		b	Introduction to solid state physics - C. Kittel

		c	Solid state physics — A. J. Dekkar
9	Barrier capacitance of a junction diode		Electronic engineering - Millman Halkias
10	Linear Voltage Differential Transformer		Electronic Instrumentation - W.D. Cooper
11	Faraday Effect-Magneto Optic Effect a) To Calibrate Electromagnet b) To determine Verdet's constant for KCI & KI solutions	a	Manual of experimental physics - E.V. Smith
		b	Experimental physics for students - Whittle & Yarwood
12	Programmes Based on Python – 1		
13	Programmes Based on Python – 2		
14	Programmes Based on Python – 3		

Programmes Based on Python – 1

a) Write a program to generate the Fibonacci series.
b) Write a program to generate if a three digit number entered is an Armstrong number or not
c) Write a function that reverses the user defined value.

Programmes Based on Python – 2

a) Write a recursive function to print the factorial for a given number.
b) Write a function that takes a character (i.e. a string of length 1) and returns True if it is a vowel, False otherwise.
c) Define a function that computes the *length* of a given list or string.

Programmes Based on Python – 3

a) Write a program that takes two lists and returns True if they have at least one common member.
b) Write a Python program to print a specified list after removing the 0th, 2nd, 4th and 5th elements.
c) Write a Python program to clone or copy a list

Group B:

	Experiment		**References**
1	Adder-subtractor circuits using ICs	a	Digital Principles and applications- Malvino and Leach
		b	Digital circuit practice-R.P.Jain
2	Study of Presettable counters- 74190 and 74193	a	Digital circuit practice-Jain & Anand
		b	Digital Principles and applications- Malvino and Leach

		c	Experiments in digital practice-Jain & Anand
3	TTL characteristics of Totem pole, Open collector and tristate devices	a	Digital circuit practice-Jain & Anand
		b	Digital Principles and applications- Malvino and Leach
4	Pulse width modulation for speed control of dc toy motor		Electronic Instrumentation - H. S. Kalsi
5	Study of sample and hold circuit		Integrated Circuits - K. R. Botkar
6	Switching Voltage Regulator		
7	Shift Registers	a	Experiments in digital principles-D.P. Leach
		b	Digital principles and applications - Malvino and Leach
8	Study of 8085 microprocessor Kit and execution of simple Programmes	a	Microprocessor Architecture, Programming and Applications with the 8085 - R. S. Gaonkar
		b	Microprocessor fundamentals. Schaum Series - Tokheim
		c	8085 Kit user manual
9	Waveform generation using 8085	a	Microprocessor Architecture, Programming and Applications with the 8085 - R. S. Gaonkar
		b	Microprocessor fundamentals. Schaum Series - Tokheim
		c	8085 Kit user manual
10	SID& SOD using 8085	a	Microprocessor Architecture, Programming and Applications with the 8085 - R. S. Gaonkar
		b	Microprocessor fundamentals. Schaum Series - Tokheim
		c	8085 Kit user manual
11	Ambient Light control power switch	a	Electronic Instrumentation H. S. Kalsi
		b	Helfrick & Cooper, PHI
12	Interfacing TTL with buzzers, relays, motors and solenoids		Digital Electronics by Roger Tokheim

Note: Minimum number of experiments to be performed and reported in the journal = 06 with minimum 3 experiments from each Group. i.e. Group A: 03 and Group B: 03.

Elective 2

Solid State Physics (505) (60 lectures, 4 credits)

Unit – I: Diffraction of Waves by Crystals and Reciprocal Lattice

Bragg law, Scattered Wave Amplitude – Fourier analysis, Reciprocal Lattice Vectors, Diffraction Conditions, Brillouin Zones, Reciprocal Lattice to SC, BCC and FCC lattice. Interference of Waves, Atomic Form Factor, Elastic Scattering by crystal, Ewald Construction, Structure Factor, Temperature Dependence of the Reflection Lines, Experimental Techniques (Laue Method, Rotating Crystal Method, Powder Method) Scattering from Surfaces, Elastic Scattering by amorphous solids.

Unit-II: Lattice Vibrations and thermal properties:

Vibrations of Monoatomic Lattice, normal mode frequencies, dispersion relation. Lattice with two atoms per unit cell, normal mode frequencies, dispersion relation., Quantization of lattice vibrations, phonon momentum, Inelastic scattering of neutrons by phonons, Surface vibrations, Inelastic Neutron scattering. Anharmonic Crystal Interaction. Thermal conductivity – Lattice Thermal Resistivity, Umklapp Process, Imperfections

Unit-III: Diamagnetism and Paramagnetism:

Langevin diamagnetic equation, diamagnetic response, Quantum mechanical formulation, core diamagnetism. Quantum Theory of Paramagnetism, Rare Earth Ions, Hund's Rule, Iron Group ions, Crystal Field Splitting and Quenching of orbital angular momentum; Adiabatic Demagnetisation of a paramagnetic Salt, Paramagnetic susceptibility of conduction electrons

Unit-IV: Magnetic Ordering:

Ferromagnetic order- Exchange Integral, Saturation magnetisation, Magnons, neutron magnetic scattering; Ferrimagnetic order, spinels, Yttrium Iron Garnets, Anti Ferromagnetic order. Ferromagnetic Domains – Anisotropy energy, origin of domains, transition region between domains, Bloch wall, Coercive force and hysteresis.

Reference:

1. Charles Kittel "Introduction to Solid State Physics", 7th edition John Wiley & sons.
2. J.Richard Christman "Fundamentals of Solid State Physics" John Wiley & sons
3. M.A.Wahab "Solid State Physics –Structure and properties of Materials" Narosa Publications 1999.
4. M. Ali Omar "Elementary Solid State Physics" Addison Wesley (LPE)
5. H.Ibach and H.Luth 3rd edition "Solid State Physics – An Introduction to Principles of Materials Science" Springer International Edition (2004)
6. Richard Feynman, Robert Leighton, Mathew Sands "The Feynman Lectures on Physics", Addison Wesley Publishing (vol. 2)