SHRI G. S. INSTITUTE OF TECHNOLOGY & SCIENCE, INDORE

DEPARTMENT OF APPLIED PHYSICS & OPTOELECTRONICS

Date : Feb. 06, 2021

Minutes of the meeting of Board of Studies held on February 06, 2021 at 2.30 pm

Meeting of Board of Studies (BOS) of Department of Applied Physics & Optoelectronics was held on February 06, 2021 at 2.30 pm using GSuite – Google Meet.

Following members attended the meeting:

1.	Dr. (Mrs.) S. Kumbhaj	Member
2.	Dr. J. T. Andrews	Chairman
3.	Ms. Nidhi Oswal	Member
4.	Mr. Gireesh G. Soni	Member
5.	Dr. Pragya Ojha	Member
6.	Dr. Vipin Kaushik	Member
7.	Dr. Abhay Kumar	Prof. & Head, SOE, DAVV – External Member
8.	Dr. Hitesh Mehta	MD, Fiber Optica Tech. - External Member

Dr. Purnima S. Khare, Prof. & Head, DNT, RGTU, External Member could not attend and convey her inability to attend.

Looking into the current Covid-19 advisory, the BOS meeting was hosted on Google Meet platform. The Chairman welcomed the members of BOS. The deliberations of the meeting are as follows:

Agenda 1: To discuss and review syllabus of B.E. (PH10006), M.Sc. and M.Tech., if needed.
Agenda 2: To introduce an open elective on Quantum Computing as per AICTE recommended curriculum.

I. PH10006 (Physics) for All Branches of B.E. / B.Tech.
Since, the syllabus is modified in the previous BOS, no corrections proposed.

II. M.Tech. (Optoelectronics)
Since, the previous BOS has reviewed the course thoroughly, no corrections proposed.

III. M.Sc. (Applied Physics)

a. **PH97105**: Classical & Statistical Mechanics: Minor changes are proposed. The old and new syllabus are enclosed as Annexures -1a and 1b, respectively. The course content is rearranged for the continuity in conducting classes. No major change added. Hence no need to change paper code.

b. **PH97106**: Electronics and Communication Engineering: Minor changes of less than 20% proposed. The old and new syllabus are enclosed as Annexures – 2a and 2b, respectively.

c. **PH97307**: Nanoscience & Nanotechnology: The course is modified as per the current demand and research interests. The old and new syllabus are enclosed as Annexures – 3a and 3b, respectively.

IV. Open Elective: Looking into the recent upsurge of interest on Quantum Computing, an open elective on Quantum Computing as per AICTE recommendations are proposed. Detailed syllabus and scheme are enclosed as Annexure – 4. Students of CS, IT, EC, EE and EI branches will be encouraged to opt for the course. Maximum of 60 students will be considered.

V. The BOS also discussed on the possibility of starting an UG course on Quantum Computing. It is decided that, if AICTE proposes new course with the nomenclature "Quantum Computing", the department will consider applying for it through proper channel.

The session concluded with the vote of thanks to the chair.

Dr. J. T. Andrews
Chairman, BOS-Dept. of Appl. Phys. & OE
and Prof. & Head, Dept. of Appl. Phys. & OE
SGSITS, Indore

Annexure 1a

PH-97105 : CLASSICAL & STATISTICAL MECHANICS

Classes				Maximum Marks			
L	T	P.	Th.	CW	SW	Pr.	Total
4	-	-	70	30	-		100

Course Objective: The objective of this course is to develop familiarity with the physical concepts and facility with the mathematical methods of classical mechanics and to develop skills in formulating and solving physics problems. Statistical Physics studies properties of many-body systems in terms of their microscopic constituents. It is a rich subject with wide varieties of applications.

Expected Outcome: The aim is to gain intuitive understandings of these principles and master the key ideas and mathematical methods used in solving the physical models. After the course, the students are expected to be able to independently study and tackle more advanced topics using the fundamental principles and methods learned in class.

1. Elementary Principle: Mechanics of systems of particles. Constraints. D'Alembert's Principle and Lagrange's equations. Velocity Dependent potentials, variational principles and Lagranges equations: Hamilton's principle. Calculus of variations, Lagranges equation from Hamilton's principle, conservation theorems and symmetry properties.
2. Two-Body central force problem: Reduction to equivalent one body problem. Virial theorems, scattering in a central force field. Rigid body: Independent co-ordinates. Orthogonal transformations, Eulerian angles. Euler's theorem.
3. Hamilton's equations of motion: Legendre's transformations. Derivation from variational principle. The principle of least action. Various forms of principles of least action and its physical significance. Canonical transformation, Examples of canonical transformation. The integral invariance of Poincare, Lagrange and Poissons brackets as canonical invariants. The equations of motions in Poisson Brackets as canonical invariants. The equations of motions in Poisson Bracket notations. Lioville Theorem.
4. Thermodynamic quantities : Macroscopic motion, relations between the derivative of thermodynamic quantities, Nerst theorem and quantum justification, the dependence of thermodynamic quantities on number of particles, thermodynamic potential, equilibrium of a body in an external field.
5. Statistical distribution : Gibbs distribution, the Maxwellian distribution, free energy in gibbs distribution, partition function, the Boltzmann distribution, the Bose Einstein distribution, Fermi Dirac distribution, the Fermi and Bose gases of elementary particles, degenerate electron gas, degenerate Bose gas, black body radiation.

Reference

1. H. Goldstein, C. Poole, J. Safko, Classical Mechanics, 3rd Ed. (Pearson Edu. South Asia), 2008.
2. N. C. Rana and P. S. Joag, Classical Mechanics, (Tata McGraw Hill Pub., New Delhi) 1991.
3. L. D. Landau and E. M. Lifshitz, Statistical Physics, 3rd Ed. (Pergemon Press, New York) 1995.
4. R. K. Patharia and P. D. Beale, Statistical Mechanics, 3rd Ed. (Elsevier Ltd., USA) 2011.

PH97105: CLASSICAL & STATISTICAL MECHANICS												
Subject Code	**Classes**			**Maximum Marks**					**Credits**			
	L	T	P	CW	End	SW	End	Total	T	P	Tot	
PH97105	4	-	-	30	70	-	-	100	4	-	4	

COURSE OBJECTIVE

CO #1 *To provide knowledge and understanding of fundamental and applied concepts of classical and statistical physics.*

CO #2 *To develop a familiarity with the theoretical laws of classical and statistical physics, and the ability to apply the theoretical framework to describe and predict the motions of bodies.*

CO #3 *To demonstrate knowledge and understanding of the fundamental concepts in the dynamics of system of particles, Lagrangian and Hamiltonian dynamics.*

CO #4 *To cultivate the understanding of macroscopic and microscopic states, the contacts of statistics and thermodynamics, ideal gas, Gibbs distribution and partition function.*

COURSE CONTENTS

Unit-1. Lagrangian and Hamiltonian Dynamics: *Mechanics of systems of particles, Constraints, D'Alembert's principle, Lagrange's equations, Conservation theorems and symmetry properties, Velocity dependent potentials, Lagrange's equation from Hamilton's variational principle, Hamilton's equations of motion, Hamilton's equations from D'Alembert's principle, Principle of least action and its forms.*

Unit-2. Two-Body Central Force Problem and Coupled Oscillations: *Reduction to equivalent one body problem, Equation of motion under central force (Kepler's law and stability of orbit), Virial theorem, Scattering in a central force field, Normal modes and coupled oscillators, General theory of small oscillation, Longitudinal oscillations of two coupled oscillators, many coupled oscillators.*

Unit-3. Canonical Transformation: *Generating functions, Application of canonical transformation, Integral invariance of Poincare, Lagrange and Poisson's brackets, Equations of motions in Poisson Brackets, Canonical invariants of Lagrange and Poissons brackets, Jacobi's Identity, Phase space and Lioville Theorem.*

Unit-4. Thermodynamic Quantities: *Macroscopic motion, relations between the derivative of thermodynamic quantities, Nerst theorem and quantum justification, the dependence of thermodynamic quantities on number of particles, thermodynamic potential, equilibrium of a body in an external field.*

Unit-5. Statistical Distribution: *Gibbs distribution, the Maxwellian distribution, free energy in Gibbs distribution, partition function, the Boltzmann distribution, the Bose Einstein distribution, Fermi Dirac distribution, the Fermi and Bose gases of elementary particles, degenerate electron gas, degenerate Bose gas, black body radiation.*

Text Books

1. H. Goldstein, C. Poole, J. Safko, Classical Mechanics, 3rd Ed. (Pearson Edu. South Asia), 2008.
2. N. C. Rana and P. S. Joag, Classical Mechanics, (Tata McGraw Hill Pub., New Delhi) 1991.
3. L. D. Landau and E. M. Lifshitz, Statistical Physics, 3rd Ed. (Pergemon Press, New York) 1995.
4. R. K. Patharia and P. D. Beale, Statistical Mechanics, 3rd Ed. (Elsevier Ltd., USA) 2011.
5. J. C. Upadhyaya, Classical Mechanics, Himalaya Publishing House, 1999.

PH 97106 : ELECTRONICS AND COMMUNICATION ENGINEERING												
Subject Code	Subject Nomenclature	Contact Hrs			Maximum Marks				Credits		
		L	T	P	CW	End	SW	End	T	P	Tot
PH 97106	Electronics and Communication Engineering	**4**	-	-	**30**	**70**	-	-	**4**	-	**4**

1. Operational amplifier : Differential amplifier, operational amplifier and its parameters, open loop applications and closed loop applications. Differential amplifiers with one, two and three OP-Amp. Frequency response.

2. General linear application of OPAMP : DC & AC amplifiers, Peaking amplifier, summing & averaging amplifier, instrumentation amplifier, integrator, differentiator, oscillators, Wein bridge, square wave, triangular wave, comparator, zero crossing detector, Schmitt trigger".

3. Modulation and demodulation : Methods of amplitude modulation, balanced modulator, SSB generation, frequency modulation and its advantages. Diode detectors, grid leak detection, AVC & AFC heterodyne receivers, super heterodyne receiver.

4. Digital electronics : Laws and theorems of Boolean algebra, DeMorgans theorem, elements of transistor for switching devices. Logic gates. Positive and negative logic; OR, AND, NOT, NAND gates. Exclusive OR operation. DTL, RTL & TTL circuits. Half & Full adders, substrator, multiplexers and demultiplexer.

5. Flip-Flops – D, RS, JK flip flop. Schmidt Trigger. Astable and monostable multivibrator, 1C555 timer. Different types of counters ad registers, ring counter, up & down counter, decade counters, serial and parallel registers.

References

1. R.A. Gayakwad, Op-amps and linear integrated circuits, (Prentice-Hall, New Delhi) 2000.
2. R.P. Singh & S.D. Sapre, Communication Systems : Analog and Digital, 2nd Ed. (Tata McGraw Hill, New Delhi) 2009.
3. M. Masis Mano, Digital Design, 4th Ed. (Prentice-Hall, New Delhi) 2006.
4. Malvino, Leach, Saha, Digital Principles & Applications, 5th Ed. (Tata-McGraw Hill, New Delhi) 1994.
5. B.P. Lalhi, Modern Digital & Analog Communication Systems, 4th Ed. (Oxford Univ. Press, UK) 2009.

Annexure – 2b

PH 97106 : ELECTRONICS AND COMMUNICATION ENGINEERING											
Subject Code	Classes			Maximum Marks					Credits		
	L	T	P	CW	End	SW	End	Total	T	P	Tot
PH97106	4	-	-	30	70	-	-	100	4	-	4

COURSE OBJECTIVES

CO #1 *To introduce the concepts of analog communication such as modulation, demodulation*

CO #2 *To equip students with knowledge of OPAMP and*

CO #3 *To train students with digital devices along with its applications.*

COURSE OUTCOME

CO #1 *Students will learn to design circuits and*

CO #2 *Students could able to develop systems based on OPAMP, logic gates, combinational and sequential devices as per needs and specification.*

COURSE CONTENTS

Unit-1. *Operational amplifier: Differential amplifier, operational amplifier and its parameters, open loop applications and closed loop applications. Differential amplifiers with one, two and three OP-Amp. Frequency response.*

Unit-2. *General linear application of OPAMP: DC & AC amplifiers, Peaking amplifier, summing & averaging amplifier, instrumentation amplifier, integrator, differentiator, oscillators, Weinbridge, square wave, triangular wave, comparator, zero crossing detector, Schmitt trigger.*

Unit-3. *Analog modulation & demodulation: AM,FM,PM, Methods of AM generation, balanced modulator, SSB generation, Power content in AM wave, transmission efficiency, Frequency modulation (FM):, frequency deviation, relationship between FM & PM, FM generation & detection, Transmission bandwidth, Super heterodyne receiver.*

Unit-4. *Digital electronics: Laws and theorems of Boolean algebra, DeMorgans theorem, elements of transistor for switching devices. Logic gates. Positive and negative logic; OR, AND, NOT, NAND gates. Exclusive OR operation. DTL, RTL & TTL circuits. Half & Full adders, substrator, multiplexers and demultiplexer.*

Unit-5. *Flip-Flops – D, RS, JK flip flop, Astable and monostable multivibrator, IC555 timer. Different types of counters and registers, ring counter, up & down counter, decade counters, serial and parallel registers.*

Text Books:

1. R.A. Gayakwad, Op-amps and linear integrated circuits, (Prentice-Hall, New Delhi) 2000.
2. R.P. Singh & S.D. Sapre, Communication Systems : Analog and Digital, 2 nd Ed. (Tata McGraw Hill, New Delhi) 2009.
3. M. Masis Mano, Digital Design, 4th Ed. (Prentice-Hall, New Delhi) 2006.
4. Malvino, Leach, Saha, Digital Principles & Applications, 5 th Ed. (Tata-McGraw Hill, New Delhi) 1994.
5. B.P. Lalhi, Modern Digital & Analog Communication Systems, 4 th Ed. (Oxford Univ. Press, UK) 2009.

Annexure – 3a

PH 97307 : NANOSCIENCE AND NANO TECHNOLOGY

Classes				Maximum Marks			
L	T	P	Th.	CW	SW	Pr.	Total
4	-	-	70	30	-		100

1. Introduction: Historical perspectives, colored glasses, Integrated circuits, Micro-electro-mechanical-systems, Advanced materials, thin films, Fullerenes and carbon nanotubes, semiconductor quantum - wells, -wires and -dots, electron probes, atomic probes.

2. Nano-Tools: Types of characterization methods, imaging, electron probe methods, SEM and electron probe microanalysis, TEM and electron diffraction, scanning probe methods, AFM, STM, Vibrational spectroscopy, UV-VIS and Fluorescence spectroscopy, X-ray methods

3. Nano-Fabrication: Top-Down and Bottom-up methods, Mechanical methods, Thermal methods, High-energy methods, Chemical methods, Lithographic methods, Gaseous state methods, Liquid state methods, solid-state methods.

4. Nano-Materials: Properties and applications of: Silicon, Silicon oxide and nitride, thin metal films, Polymers, Gallium Arsenide and other III-V semiconductors, shape memory alloys.

5. MEMS & NEMS: Sensing and actuation, pressure-, flow-, acceleration-sensors, Imaging and display, DMD, Laser tuning, Wavelength locker, $M \times N$ optical switch, microfluidics, mixing microfluids, DNA analysis, Applications to RF system.

References :

1. S. Lindsay, Introduction to Nanoscience, (Oxford university Press, 2014).
2. N. Maluf, K. Williams, An Introduction to Microelectromechanical Systems Engineering, Second Edition, (Artech House Boston 2004).
3. J. H. Davies, The Physics of Low-dimensional semiconductors (Cambridge, Cambridge, 1998).
4. S. K. Kulkarni, Nanotechnology: Principles and Practices (Capitol, Delhi 2007)

PH-----: NANO SCIENCE & NANO TECHNOLOGY											
Subject Code	Classes			Maximum Marks					Credits		
	L	T	P	CW	End	SW	End	Total	T	P	Tot
PH------	4	-	-	30	70	-	-	100	4	-	4

COURSE OBJECTIVE

CO# 1 To provide understanding of fundamental and applied concepts of nano materials.

CO# 2 To develop a familiarity with the characterization tools used for the analysis of electrical optical and structural properties of nano materials.

CO# 3 To demonstrate the basic functioning of nano fabrication techniques.

CO# 4 To cultivate the fundamental understanding of metal semiconductor alloys, micro and nano elector mechanical systems.

COURSE CONTENTS

Unit-1. Introduction: *Photon and phonon, fermi distribution and density of states, doping and alloying, electron waves, effective mass of electron and holes, energy band gap, drift, diffusion and tunneling, boundary conditions, metal-semiconductor contacts, carrier mobility, exitons.*

Unit-2. Characterization-Tools: *Scanning electron microscopy and energy dispersive x-ray, tunnelling electron microscopy, atomic force microscopy, UV-VIS spectroscopy, fluorescence spectroscopy, x-ray diffraction, I-V, C-V and Q-V measurements.*

Unit-3. Fabrication Techniques: *Top-down and bottom-up methods, molecular beam epitaxy, atomic layer deposition, pulsed laser deposition, chemical vapor deposition, spin coating, thermal and magnetron sputtering, UV optical lithography.*

Unit-4. Materials Properties: *3D, 2D, 1D and 0D confinement of nanostructure, Optical and electrical properties: Si, Ge,* SiO_2, *SiN, GaAs, InSb, CdS, CdSe, ZnO,* $Al_xGa_{1-x}N$, $Al_xGa_{1-x}As$, $In_xN_{1-x}P$, $Cd_xSe_{1-x}Te$, $S_xZn_{1-x}O$, $Al_xGa_{1-x}In_yAs_{1-y}$, $Al_xGa_{1-x}As_yIn_{1-y}$, $Mg_xZn_{1-x}S_yTe_{1-y}$.

Unit-5. MEMS & NEMS: *Sensing and actuation, pressure-, flow-, acceleration-sensors, imaging and display, DMD, laser tuning, wavelength locker, M x N optical switch, microfluidics, mixing microfluids, Applications to RF system.*

Text Books:

1. S. Lindsay, Introduction to Nanoscience, (Oxford university Press, 2014).
2. N. Maluf, K. Williams, An Introduction to Microelectromechanical Systems Engineering, Second Edition, (Artech House Boston 2004).
3. J. H. Davies, The Physics of Low-dimensional semiconductors (Cambridge, Cambridge, 1998).
4. S. K. Kulkarni, Nanotechnology: Principles and Practices (Capitol, Delhi 2007)
5. J. Piprek, Semiconductor optoelectronic Devices, Introduction to physics and simulation, Academic Press, London, 2003.

OC_ _ _ _ _ - Quantum Computing											
Subject Code	Subject Nomenclature	Contact hrs			Maximum Marks				Credits		
		L	T	P	CW	End	SW	End	T	P	Tot
OC_ _ _ _ _	Quantum Computing	**4**	**0**	**2**	**30**	**70**	**20**	**30**	**4**	**1**	**5**

PREREQUSITES:

Physics (First Year), knowledge of programing in *Python* or *C#*, Data Structure and Algorithm.

COURSE OBJECTIVES

CO #1 *To impart knowledge and understanding foundations of Quantum mechanics.*
CO #2 *To generate attitude and interest to develop and implement quantum algorithm.*
CO #3 *To update the knowledge of quantum physics to write program for quantum algorithm.*
CO #4 *To identify, conduct, formulate and solve quantum logic operations*

COURSE CONTENTS

Unit-1. Introduction to QC: *Motivation, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.), Origin of QC, Overview of major concepts, Qubits and multi-qubits states, Bra-ket notation, Bloch Sphere representation, Quantum Superposition, Quantum Entanglement.*

Unit-2. Mathematical foundations: *Basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.*

Unit-3. Building Blocks: *P Architecture, Details of q-bit system of information representation, Bloch Sphere, Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition), Quantum Entanglement, Useful states from quantum algorithmic perceptive, Bell State, Operation on qubits: Measuring and transforming using gates.*

Unit-4. Quantum Logic gates and Circuit: *Pauli, Hadamard, phase shift, controlled gates, Ising, Deutsch, swap etc., Programming model for a Quantum Computing Program, Steps performed on classical computer, Steps performed on Quantum Computer, Moving data between bits and qubits.*

Unit-5. Quantum Algorithm: *Basic techniques exploited by quantum algorithms, Amplitude amplification, Quantum Fourier Transform, Phase Kick-back, Quantum Phase estimation, Quantum Walks, Major Algorithms, Shor's Algorithm, Grover's Algorithm. Deutsch's Algorithm, Deutsch - Jozsa Algorithm, OSS Toolkits for implementing Quantum program, IBM quantum experience, Microsoft Q, Rigetti PyQuil (QPU/QVM).*

LIST OF EXPERIMENTS

1. *Building Quantum dice*
2. *Building Quantum Random number Generation*
3. *Composing simple quantum circuits with q-gates and measuring the output into classical bits.*
4. *Implementation of Shor's Algorithms*
5. *Implementation of Grover's Algorithm*
6. *Implementation of Deutsch's Algorithm*
7. *Implementation of Deutsch-Jozsa's Algorithm*
8. *Implementing an API for efficient search using Grover's Algorithms or Integer factorization using Shor's Algorithm*

TEXT BOOKS

1. M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information (Cambridge University Press, Cambridge 2010).
2. D. McMahon, Quantum Computing Explained, (John-Wiley, New Jersey 2018)
3. V. Sahni, Quantum Computing (McGraw Hill, New Delhi 2007).
4. IBM Experience: https://quantumexperience,ng,bluemix.net
5. Microsoft Quantum Development Kit: https://www.microsoft.com/en-us/quantum/development-kit
6. Forest SDK PyQuil: https://pyquil.readthedocs.io/en/stable/

COURSE OUTCOME

At the end of one-semester course, the students will be able

CO #1 *Explain the working of a Quantum Computing program, its architecture and program model*

CO #2 *Develop quantum logic gate circuits*

CO #3 *Develop quantum algorithm*

CO #4 *Program quantum algorithm on major toolkits*