UNIVERSITY OF MUMBAI

SYLLABUS FOR SEM - V & VI

Program: B.Sc.

Course: Physics

(Credit Based Semester and Grading System
w. e. f. the academic year 2018–2019)

T.Y.B.Sc. Physics Syllabus: Credit Based Semester and Grading System to be implemented from the Academic year 2018-2019.

SEMESTER V				
Theory				
Course	**UNIT**	**TOPICS**	**Credits**	**Lectures per Week**
USPH501	I	Mathematical Methods in Physics	**2.5**	**4**
	II	Mathematical Methods in Physics		
	III	Thermal and Statistical Physics		
	IV	Thermal and Statistical Physics		
USPH502	I	Solid State Physics	**2.5**	**4**
	II	Solid State Physics		
	III	Solid State Physics		
	IV	Solid State Physics		
USPH503	I	Atomic Physics	**2.5**	**4**
	II	Atomic Physics		
	III	Molecular Physics		
	IV	Molecular Physics		
USPH504	I	Electrodynamics	**2.5**	**4**
	II	Electrodynamics		
	III	Electrodynamics		
	IV	Electrodynamics		
Practicals				
USPHP05	Practicals of Course USPH501 + Course USPH502		**2.5**	**6**
USPHP06	Practicals of Course USPH503 + Course USPH504		**2.5**	**6**
Project				
USPHPR1	USPH501 + USPH502 + USPH503 + USPH504		**1**	**4**

SEMESTER VI				
Theory				
Course	**UNIT**	**TOPICS**	**Credits**	**Lectures per Week**
USPH601	I	Classical Mechanics	**2.5**	**4**
	II	Classical Mechanics		
	III	Classical Mechanics		
	IV	Classical Mechanics		
USPH602	I	Electronics	**2.5**	**4**
	II	Electronics		
	III	Electronics		
	IV	Electronics		
USPH603	I	Nuclear Physics	**2.5**	**4**
	II	Nuclear Physics		
	III	Nuclear Physics		
	IV	Nuclear Physics		
USPH604	I	Special Theory of Relativity	**2.5**	**4**
	II	Special Theory of Relativity		
	III	Special Theory of Relativity		
	IV	Special Theory of Relativity		
Practicals				
USPH605	Practicals of Course USPH601 + Course USPH602		**2.5**	**6**
USPH606	Practicals of Course USPH603 + Course USPH604		**2.5**	**6**
Project				
USPHPR2	USPH601 + USPH602 + USPH603 + USPH604		**1**	**4**

SCHEME OF THEORY, PRACTICALS AND PROJECT EXAMINATION (SEM- V & VI)

<table>
<tr><td rowspan="8">I.</td><td colspan="2">Theory: External Examination: 100 marks</td></tr>
<tr><td colspan="2">Each theory paper shall be of THREE hours duration.</td></tr>
<tr><td colspan="2">Each paper shall consist of FIVE questions. All questions are compulsory and will have internal options. Choice in papers has to be 1.5 times.</td></tr>
<tr><td>Q – I :</td><td>From Unit – I</td></tr>
<tr><td>Q – II :</td><td>From Unit – II</td></tr>
<tr><td>Q – III :</td><td>From Unit - III</td></tr>
<tr><td>Q – IV :</td><td>From Unit - IV</td></tr>
<tr><td>Q – V :</td><td>Will consist of questions from all the FOUR Units with equal weightage of marks allotted to each Unit.</td></tr>
<tr><td>II.</td><td colspan="2">Practicals and Project: The External Practical Examination will be conducted as per the following scheme.</td></tr>
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<table>
<tr><td>Sr. No.</td><td colspan="3">Particulars of External Practical and Project Examination</td><td>Total Marks</td></tr>
<tr><td>1</td><td>Laboratory Work</td><td>Experiment-1= 60 M</td><td>Experiment-2 = 60 M</td><td>120</td></tr>
<tr><td>2</td><td>Journal</td><td>10</td><td>10</td><td>20</td></tr>
<tr><td>3</td><td>Viva</td><td>10</td><td>10</td><td>20</td></tr>
<tr><td colspan="4">Sub Total =</td><td>160</td></tr>
<tr><td>III.</td><td>Project</td><td>Internal Examiner (20 M)</td><td>External Examiner (20 M)</td><td>40</td></tr>
<tr><td colspan="4">Grand Total</td><td>200</td></tr>
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Passing Criteria:

1. A student should be considered as passed in the practical examination provided he/she fulfills the following passing criteria
   a. Minimum of 20 marks in each practical component - i.e. **USPHP07** and **USPHP08.**
   b. Minimum of 10 marks in Project Component
   c. And cumulatively scoring 80 marks (i.e. 40 % of 200 marks)

Component	**Maximum Marks**	**Minimum Passing Marks**
USPHP07	80	20
USPHP08	80	20
Project 2	40	10
Total	**200**	**80**

Scheme of Examination:

1. The University (external) examination for Theory and Practical shall be conducted at the end of each Semester and the evaluation of Project work at the end of the each Semester.
2. The candidate should appear for **THREE** Practical sessions of **three hours each** as part of his/her Practical course examination.
3. The candidates shall appear for external examination of 2 practical courses each carrying 80 marks and presentation of project work carrying 20 marks at the end of each semester.
4. The candidates shall also appear for internal presentation of project work carrying 20 marks at the end of each semester.
5. The candidate shall prepare and submit for practical examination a certified Journal based on the practical course with **6** experiments from each group.
6. The certified journal must contain a minimum of **12** regular experiments (**6** from each group), **with** minimum **5** demonstration experiments in semester VI. A separate index and certificate in journal is must for each semester course.
7. At the time of practical examination, the candidate must also submit the certified Project Report prepared as per the guidelines given in the Syllabus.

A candidate will be allowed to appear for the practical examination only if the candidate submits a certified journal of TYBSc Physics or a certificate from the Head of the Department to the effect that the candidate has completed the practical course of TYBSc Physics as per the minimum requirements and a project completion report duly certified by the project in-charge and Head of the Department.

III. Visits: Visits to industry, national research laboratories, and scientific exhibitions should be encouraged.

Theory Course - USPH502: Solid State Physics

Learning Outcomes: On successful completion of this course students will be able to:

1. Understand the basics of crystallography, Electrical properties of metals, Band Theory of solids, demarcation among the types of materials, Semiconductor Physics and Superconductivity.
2. Understand the basic concepts of Fermi probability distribution function, Density of states, conduction in semiconductors and BCS theory of superconductivity.
3. Demonstrate quantitative problem solving skills in all the topics covered.

<table>
<tr><td>Unit - I</td><td>Crystal Physics</td><td>(15 lect.)</td></tr>
<tr><td colspan="3">The crystalline state, Basic definitions of crystal lattice, basis vectors, unit cell, primitive and non-primitive cells, The fourteen Bravais lattices and the seven crystal systems, elements of symmetry, nomenclature of crystal directions and crystal planes, Miller Indices, spacing between the planes of the same Miller indices, examples of simple crystal structures, The reciprocal lattice and X-ray diffraction.

Ref: Elementary Solid State Physics-Principles and Applications: M. Ali Omar, Pearson Education, 2012 : (1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 2.6)</td></tr>
<tr><td>Unit -II</td><td>Electrical properties of metals</td><td>(15 lect.)</td></tr>
<tr><td colspan="3">1. Classical free electron theory of metals, Drawbacks of classical theory, Relaxation time, Collision time and mean free path

2. Quantum theory of free electrons, Fermi Dirac statistics and electronic distribution in solids, Density of energy states and Fermi energy, The Fermi distribution function, Heat capacity of the Electron gas, Mean energy of electron gas at 0 K, Electrical conductivity from quantum mechanical considerations, Failure of Sommerfeld's free electron Theory

3. Thermionic Emission</td></tr>
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Ref.: Solid State Physics: S. O. Pillai, New Age International. 6^{th} Ed. Chapter 6: II, III, IV, V, XIV, XV, XVI, XVII, XVIII, XX, XXXV, XXXI.		
Unit -III	**Band Theory of Solids and Conduction in Semiconductors**	(15 lect.)
1. Band theory of solids, The Kronig- Penney model (Omit eq. 6.184 to 6.188), Brillouin zones, Number of wave functions in a band, Motion of electrons in a one-dimensional periodic potential, Distinction between metals, insulators and intrinsic semiconductors. Ref.: Solid State Physics: S. O. Pillai, New Age International, 6^{th} Ed. Chapter 6: XXXVI, XXXVII, XXXVIII, XXXIX, XXXX, XXXXI 2. Electrons and Holes in an Intrinsic Semiconductor, Conductivity of a Semiconductor, Carrier concentrations in an intrinsic semiconductor, Donor and Acceptor impurities, Charge densities in a semiconductor, Fermi level in extrinsic semiconductors, Diffusion, Carrier lifetime, The continuity equation, Hall Effect. Ref.: Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (3^{rd} Ed.) Tata McGraw Hill.: 4.1 to 4.10.		
Unit -IV	**Diode Theory and superconductivity**	(15 lect.)
1. Semiconductor-diode Characteristics: Qualitative theory of the p-n junction, The p-n junction as a diode, Band structure of an open-circuit p-n junction, The current components in a p-n junction diode, Quantitative theory of p-n diode currents, The Volt-Ampere characteristics, The temperature dependence of p-n characteristics, Diode resistance. Ref.: Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (3^{rd} Ed.) Tata McGraw Hill.: 5.1 to 5.8 2. Superconductivity: Experimental Survey, Occurrence of Superconductivity, destruction of superconductivity by magnetic field, The Meissner effect, London equation, BCS theory of superconductivity, Type I and Type II Superconductors, Vortex state. Ref.: Introduction to Solid State Physics-Charles Kittel, 7^{th} Ed. John Wiley &		

Sons: Topics from Chapter 12.

Main References:

1.	Elementary Solid State Physics-Principles and Applications: M.Ali Omar, Pearson Education, 2012.
2.	Solid State Physics: S. O. Pillai, New Age International, 6^{th} Ed.
3.	Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (3^{rd} Ed.) Tata McGraw Hill.
4.	Introduction to Solid State Physics - Charles Kittel, 7^{th} Ed. John Wiley & Sons.
5.	Modern Physics and Solid State Physics: Problems and solutions New Age International.
Additional References:	
1.	Solid State Physics: A. J. Dekker, Prentice Hall.
2.	Electronic Properties of Materials: Rolf Hummel, 3^{rd} Ed. Springer.
3.	Semiconductor Devices: Physics and Technology, 2^{nd} Ed. John Wiley & Sons.
4.	Solid State Physics: Ashcroft & Mermin, Harcourt College Publisher.

Theory Course – USPH602: Electronics

Learning Outcome:

On successful completion of this course students will be able to:

1. Understand the basics of semiconductor devices and their applications.
2. Understand the basic concepts of operational amplifier: its prototype and applications as instrumentation amplifier, active filters, comparators and waveform generation.
3. Understand the basic concepts of timing pulse generation and regulated power supplies
4. Understand the basic electronic circuits for universal logic building blocks and basic concepts of digital communication.
5. Develop quantitative problem solving skills in all the topics covered.

<table>
<tr><td>Unit - I</td><td></td><td>(15 lect.)</td></tr>
<tr><td colspan="3">1. Field effect transistors: JFET: Basic ideas, Drain curve, The transconductance curve, Biasing in the ohmic region and the active region, Transconductance, JFET common source amplifier, JFET analog switch, multiplexer, voltage controlled resistor, Current sourcing.

2. MOSFET: Depletion and enhancement mode, MOSFET operation and characteristics, digital switching.

3. SCR – construction, static characteristics, Analysis of the operation of SCR, Gate Triggering Characteristics, Variable half wave rectifier and Variable full wave rectifier, Current ratings of SCR.

4. UJT: Construction, Operation, characteristics and application as a relaxation oscillator.

1. MB: 13.1 to 13.9
2. MB: 14.1, 14.2, 14.4, 14.6.
3. AM: 28.1, 28.5</td></tr>
<tr><td>Unit -II</td><td></td><td>(15 lect.)</td></tr>
<tr><td colspan="3">1. Differential Amplifier using transistor: The Differential Amplifier, DC and AC analysis of a differential amplifier, Input characteristic-effect of input bias, offset current and input offset voltage on output, common mode gain, CMRR.</td></tr>
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2. Op Amp Applications: Log amplifier, Instrumentation amplifiers, Voltage controlled current sources (grounded load), First order Active filters, Astable using OP AMP, square wave and triangular wave generator using OP AMP, Wein-bridge oscillator using OP AMP, Comparators with Hysteresis, Window Comparator.

1. MB: 17.1 to 17.5
2. MB: 20.5, 20.8, 21.4, 22.2, 22.3, 22.7, 22.8, 23.

Unit -III		(15 lect.)

1. Transistor Multivibrators: Astable, Monostable and Bistable Multivibrators, Schmitt trigger.

2. 555 Timer: Review Block diagram, Monostable and Astable operation Voltage Controlled Oscillator, Pulse Width modulator, Pulse Position Modulator, Triggered linear ramp generator.

3. Regulated DC power supply: Supply characteristics, series voltage regulator, Short circuit protection (current limit and fold back) Monolithic linear IC voltage Regulators. (LM 78XX, LM 79XX, LM 317, LM337).

1. AM: 18.11
2. KVR: 14.5.2.1, 14.5.2.5, 14.5.2.6, 14.5.4.1
3. MB: 23.8, 23.9
4. MB: 24.1, 24.3, 24.4

Unit -IV		(15 lect.)

1. Logic families: Standard TTL NAND, TTL NOR, Open collector gates, Three state TTL devices, MOS inverters, CMOS NAND and NOR gates, CMOS characteristics.

2. Digital Communication Techniques: Digital Transmission of Data, Benefits of Digital Communication, Disadvantages of Digital Communication, Parallel and Serial Transmission, Pulse Modulation, Comparing Pulse-Modulation Methods (PAM, PWM, PPM), Pulse-Code Modulation.

1. ML: 6.2, 6.4, 6.6, 6.7, 7.2 to 7.4.
2. LF: 7.1, 7.2, 7.4

References	
1.	MB: Electronic Principles, Malvino & Bates -7th Ed TMH Publication.
2.	AM: Electronic Devices and Circuits, Allen Mottershead -PHI Publication.
3.	KVR: Functional Electronics, K.V. Ramanan-TMH Publication.
4.	ML: Digital Principles and Applications, Malvino and Leach (4th Ed)(TMH).
5.	LF: Communication Electronics: Principles and applications, Louis E Frenzel 4th edition TMH Publications.