Course title	Introduction to Physics of Industrial Materials		
Course code	PHY401X2		
Credit value	02		
Hourly breakdown	**Theory**	**Practical**	**Independent Learning**
	30	-	70

Objectives

- Explain the underlying physics of materials used in industry
- Outline the potential applications of materials in the industry
- Introduce material characterization techniques related to industry

Intended learning outcomes

- Discuss the properties of industrial materials
- Classify nanomaterials based on dimensions
- Discuss the health risks posed by nanomaterials
- Determination of phase composition, formation of microstructures of metal alloys using phase diagram
- Explain the working principle of various material characterization tools.

Contents

Industrial Materials: Types of materials, Physics of semiconductors, Semiconductor devices, Magnetism & Magnetic Materials, Applications of magnetic materials, Superconductors, Types of superconductors, High temperature superconductors, Applications of superconductors, Nanomaterials, Classification of nanomaterials based on dimensions, Health risk of nanomaterials, Nanobiomaterials, Introduction to phase diagram.

Material Characterization techniques: X-ray diffraction (XRD), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), UV-Vis spectroscopy, Four probe technique, Hall measurement.

Teaching and Learning Methods / Activities

- Lectures, Tutorial discussion, Online teaching, Educational Resources

Evaluation

In-Course Assessments	30 %
End of Course Examination	70 %

Recommended References

- Donald, A. N. (2011). Semiconductor Physics and devices: Basic Principles. 4th ed. McGraw-Hill.
- Cullity, B.D. and Graham, C.D. (2008). Introduction to Magnetic Materials. 2nd ed. Wiley.
- Ashcroft, N.W., and Mermin, N.D. (2011). Solid State Physics. Cengage Learning.
- Dieter, V. (2013). Nanomaterials: An Introduction to Synthesis. Properties and Applications. 2nd ed. Wiley.
- Joseph, I. G., Dale, E. N., Joseph, R. M., Nicholas, W.M.R., John, H. J. S., and David, C. J. (2017). Scanning Electron Microscopy and X-Ray Microanalysis, 4th ed. Springer.
- Williams, D. B., and Carter, C. B. (2009). Transmission Electron Microscopy: A Textbook for Materials Science. 2nd ed. Springer.

Course title	Minerals, Ceramics and their Industrial Applications		
Course code	PHY402X2		
Credit value	02		
Hourly breakdown	**Theory**	**Practical**	**Independent Learning**
	30	-	70

Objectives

- Introduce the mineral resources of Sri Lanka and their commercial values
- Explain the advancements in the processing of ceramic components and their integrative designs for industrial applications

Intended learning outcomes

- Classify the mineral resources available in Sri Lanka
- Discuss the importance of value addition of local minerals in the economy
- Describe the fabrication and of ceramic articles
- Interpret the mechanical, thermal, electrical and piezoelectric properties of ceramic articles
- Explain the types, manufacturing process and application of cement and concrete

Contents

Minerals: Types of rocks and minerals, Rocks and Mineral resources of Sri Lanka, Graphite, Ilmenite, Rutile, Zircon, Quartz, Feldspar, Clay, Kaolin, Apatite (Phosphate Rock), Silica Sand, Garnet Sand, Mica, Calcite and Dolomite, Occurrence of mineral deposits; their present uses and future potential, Environmental impacts on mineral mining, Value addition to the minerals and their applications

Ceramics: Introduction and history of ceramics, Ionic bonding, lattice energy, covalent bonding, defects in solids, properties of interfaces and grain boundaries, melting point, thermal expansion, grain size, grain boundaries and surfaces.

Ceramic Processing: Powder preparation and characterization, green compact production, sintering and densification, different types of furnaces/kilns, usage of phase diagrams in synthesis and sintering.

Mechanical Properties of ceramics: Methods of strength and toughness measurements, Fracture, strength, Young's Modulus, Hardness, microstructure/ mechanical property relationships.

Cement and Concrete: Concepts of hydraulic materials, basic raw materials, manufacturing processes, basic composition of ordinary Portland cement (OPC), compound formation, setting and hardening tests of cement and concrete

Teaching and Learning Methods / Activities

- Lectures, Tutorial discussion, Online teaching, Educational Resources

Evaluation

In-Course Assessments	30 %
End of Course Examination	70 %

Recommended References

- Bengisu, M. (2001). Engineering Ceramics. Springer.
- Yoshihiko, I. (2012). Advanced Ceramic Technologies & Products. Springer.
- Carter, C. B., and Norton, M. G. (2013). Ceramic Materials Science and Engineering. 2nd ed. Springer.

Course title	Polymers and their Industrial Applications		
Course code	PHY403X2		
Credit value	02		
Hourly breakdown	**Theory**	**Practical**	**Independent Learning**
	30	-	70

Objectives

- Introduce different types of polymer architectures and polymerization techniques
- Explain the structural, electrical and electronic properties of polymers
- Illustrate important applications of polymers in present day technological world
- Introduce various types of polymer processing techniques
- Discuss ionically and electronically conducting polymers

Intended learning outcomes

- Discuss various types of polymers and polymerization techniques
- Summarise electrical and electronic properties of polymers
- Distinguish different moulding techniques
- Compare different doping methods in polymers
- Identify important applications of conducting polymers

Contents

Introduction to Polymers: Monomers, polymers, types of polymers, polymerization techniques, average molar masses, poly-dispersity, glass transition temperature and factors affecting the glass transition temperature.

Structural Properties of Polymers: Radius of gyration, volume fraction of a polymer chain, viscosity of dilute polymer solution (the Zimm Theory), molten polymer (the Rouse Theory), diffusion in molten polymers, elastic properties of rubber, effect of temperature on elastic modulus, fibre-polymer composites, processing techniques of polymer articles (moulding, forming, lamination, reinforcement and coating), advantages and disadvantages of different moulding techniques.

Electrical and Electronic Properties of Polymers: History, conjugation, pi and sigma bonds, electronic structure of polymeric solids, molecular orbits, ionization potentials, electron affinity, oxidative and reductive doping, different doping methods, optical absorption and emission of polymers, basic operation of polymer solar cells and light emitting diodes, potential applications of conjugated polymers, advantages and disadvantages of conjugated polymers.

Teaching and Learning Methods / Activities

- Lectures, Tutorial discussion, Online teaching, Educational Resources

Evaluation

In-Course Assessments 30 %
End of Course Examination 70 %

Recommended References

- Michael, M. C., and Paul, C. P. (1998). Fundamentals of Polymer Science: An Introductory Text - CRC Press.
- Paul, C. P., and Michael, M. C. (2008). Essentials of Polymer Science and Engineering. DEStech Publications Inc.
- Robert, J. Y., and Peter, A. L. (2011). Introduction to Polymers. 3rd ed. CRC Press.

Course title	Applied Electronics		
Course code	PHY404X2		
Credit value	02		
Hourly breakdown	**Theory**	**Practical**	**Independent Learning**
	30	-	70

Objectives

- Impart knowledge on electronics in a way that it can applied for solving problems related to electronics in the industrial environment

Intended learning outcomes

- Discuss the frequency response of a transistor amplifier
- Design electronic circuits using linear integrated circuits
- Explain the architecture and applications of microcontrollers
- Design electronic systems using microcontrollers

Contents

Frequency response of transistor amplifiers: Bipolar junction transistor (BJT) amplifiers, Hybrid-pi model of a BJT, common emitter and common collector amplifier, field effect transistor (FET) amplifiers, frequency response of common source and source follower amplifiers, metal-oxide semiconductor FETs (MOSFET), MOSFET amplifiers

Linear integrated circuits: Introduction to integrated circuits (ICs), IC741, types of IC741, and their application in analogue computing, IC555, operation of IC 555, astable, monostabe and bistable multivibrators

Microcontrollers: Introduction to microprocessors, and microcontrollers, microcontroller programming, interfacing various input and output components, designing simple systems using microcontrollers

Teaching and Learning Methods / Activities

- Lectures, Tutorial discussion, Online teaching, Educational Resources

Evaluation

In-Course Assessments 30 %
End of Course Examination 70 %

Recommended References

- Donald, A. N. (2011). Semiconductor Physics and devices: Basic Principles. 4th ed. McGraw-Hill.
- Cullity, B.D., and Graham, C.D. (2008). Introduction to Magnetic Materials. 2nd ed. Wiley.
- Ashcroft, N.W., and Mermin, N.D. (2011). Solid State Physics. Cengage Learning.
- Dieter, V. (2013). Nanomaterials: An Introduction to Synthesis. Properties and Applications. 2nd ed. Wiley.

Course title	Applied Thermodynamics		
Course code	PHY405X2		
Credit value	02		
Hourly breakdown	**Theory**	**Practical**	**Independent Learning**
	30	-	70

Objectives

- Familiarize with air standard cycles and appreciation of their application to internal combustion engines
- Enabling students to analyze vapour power cycles relevant to the steam power plant and appreciate the working of the plant and its components
- Impart the operation of refrigeration systems and application to air-conditioning
- Describe the principles of different modes of heat transferring in the choice of heat exchangers.
- Explain the application to air compressors

Intended learning outcomes

- Analyze a variety of heat engines based on air standard with emphasizing the working mechanism of internal combustion engines
- Analyze the performance and function of major elements of steam power plant
- Define the criteria of performance of refrigerators, and air conditions and heat pumps
- Calculate heat transfer with combined modes of heat transfer with the focus on the selection of non-mixing type heat exchangers
- Analyze performance of reciprocating air compressors

Contents

Air standard cycles for engines

Functional principles of power cycles; Carnot, Otto and Diesel cycles, Stirling and Ericsson cycles, Internal combustion engine; Fuels and combustion.

Vapour power cycles and its application in steam power:

Energy analysis of steady-flow systems: Rankine cycle, superheat cycle

Industrial applications of steam; Steam power plants: performance, plant layout, major and elements

Heat Pump and Refrigerator as Reversed Heat Engine:

Reversed thermal power cycles as heat pump and refrigeration cycles.

Industrial refrigeration systems. Thermoelectric coolers: Peltier effect

Combined Modes of Heat Transfer:

Combined modes of heat transfer in industrial practice. Heat exchanger theory and selection of devices;

Heat removal devices: radiators, heat sinks, heat tubes and heat spreaders.

Air compression:

Types of air compressors, performance analysis of reciprocating compressors, Industrial uses of compressed air

Teaching and Learning Methods / Activities
• Lectures, Tutorial discussion, Online teaching, Educational Resources
Evaluation
In-Course Assessments 30 % End of Course Examination 70 %
Recommended References
• Yunus, A. C., Michael, A. B., and Mehmet, K. (2019). Thermodynamics: An Engineering Approach. 9th ed. McGraw-Hill Education. • Theodore, L. B., Adrienne, S. L., Frank, P. I., and David, P. D. (2011). Fundamentals of Heat and Mass Transfer. 7th ed. John Wiley. • Achuthan, M. (2009). Engineering Thermodynamics. 2nd ed. PHI Publisher. • Eastop, T. D. (1996). Applied Thermodynamics for Engineering Technologists. 5th ed. Pearson United Kingdom.

Course title	Laboratory Based Workshop Practice		
Course code	PHY406X2		
Credit value	02		
Hourly breakdown	**Theory**	**Practical**	**Independent Learning**
	-	60	40

Objectives

- Introduce the working environment of a workshop along with tools, machines and hazard management.

Intended learning outcomes

- Develop safe working habits to avoid various industrial hazards
- Utilize simple tools for making geometries using wooden planks and metal sheets
- Make use of lathe machine to make simple metal and wooden articles
- Compare different cutting, welding and soldering methods
- Construct simple electronic circuits using printed circuit board and electronic components

Contents

Health and Safety: Safety usage and maintenance of tools, electrical hazards, chemical safety, fire-fighting and health hazards, potential accidents in the workplace and protection, safety disposal of wastes

Measurements: Linear measurements, measurement of angles, dial indicator, engineering drawing and geometrical constructions.

Tools: Hand Tools – hammers, screw drivers, pliers, spanners, wrenches, allen keys, chisels, files, hacksaws, scrapers, taps, dies and metal sheet cutting tools; Machining and polishing, twist drill and reamers.

Cutting: The wedge in metal cutting, types of chips, prevention of chip welding, application of cutting angles (chisel, file, hacksaw, scraper and thread cutting).

Welding: Introduction to gas and arc welding, spot and seam welding, soldering.

Lathe: Construction features, basic alignments, movements and the operation of the centre lathe.

Electronic circuit: Printed circuit boards, micro drills, identifying electronic components and terminals, soldering and de-soldering and testing

Teaching and Learning Methods / Activities

- Laboratory work / workshop training

Evaluation

Continuous assessments (Lab work and reports)	30 %
In-Course assessments (practical)	30 %
End of Course Examination (Design works)	40 %

Recommended References

- Rajendar, S. (2006). Introduction to Basic Manufacturing Process and Workshop Technology. New age international publisher.
- Chapman, W. (2013). Workshop technology – Part 2 Routledge, Taylor & Francis .

Course title	Laboratory Work in Industrial Materials		
Course code	PHY407X2		
Credit value	02		
Hourly breakdown	Theory	Practical	Independent Learning
	-	60	40

Objectives

- Perform experiments for the analysis of various materials including natural, industrial and environmental samples
- Demonstrate the interpersonal skills through seminar presentations

Intended learning outcomes

- Demonstrate the fundamental concepts/laws in physics by setting up laboratory equipment safely and efficiently
- carry out experimental procedures
- Illustrate the ability to apply knowledge/skills to real world settings by identifying possible sources of error
- Implementing techniques that enhance precision
- Develop critical thinking/ analytical reasoning ability through interpreting experimental data
- Prepare effective oral/written communication skills/ability by reporting verbally and in written language the experimental data, results, and assessment of reliability

Contents

Laboratory work: Energy Bandgap of semiconductor material, Hall voltage and Hall-coefficient sample material, Lee's Disc, Liner integrated circuit and microcontrollers, Analog Computing, Electro Chemical Impedance spectroscopy studies on Polymer Electrolytes, Phase identification of ceramic compounds, Density of Ceramics. Crystal structure of ceramics (XRD), Introduction to internal combustion engines – engine cutaway models, Analysis of internal combustion engine, Marcet-boiler, Test on steam power plant with steam engine, Steam power plant with steam engine, Two stage air compressor, Water cooling tower, Analyzing the heat transfer coefficient in heat exchanger, Test on vapour compression refrigeration

Teaching and Learning Methods / Activities

- Laboratory experiments, Analysis of data, Hands on training

Evaluation

Continuous Assessments (Lab report)	40 %
Oral presentation	40%
End of course Examination	20%

Recommended References

- Pergament, M. I. (2015). Method of Experimental Physics. CRC Press.
- Louis, L. (1995). Practical Guide to Data Analysis for Physics Science Students. Cambridge University Press.
- Kraftmakhe, Y. (2015). Experiments and Demonstrations in Physics. World Scientific.

Course title	Industrial Training		
Course code	PHY408X8		
Credit value	08 (4 – 6 months of industrial training)		
Hourly breakdown	Theory	Practical	Independent Learning
	-	-	600

Objectives

- Expose real working environment and get acquainted with the organization structure, business operations and administrative functions.
- Impart knowledge through hands-on experience in the related field so that they can relate and reinforce what has been taught at the university.
- Set the stage for future recruitment by potential employers.

Intended learning outcomes

- Analyze the industrial problem to identify the appropriate solving methodology
- Design industrial experiments in a systematic approach
- Familiarize latest changes in technology
- Identify sources of hazards, appropriate health and safety measures.
- Improve team working skill, leadership skill and responsibilities in the work environment
- Develop synergetic collaboration between industry and the university in promoting a knowledgeable society

Course description

Students will be trained in an industry for a period of 4–6 months under the guidance of academic and industrial supervisors. They should maintain an industrial diary during the training period . On completion of the industrial training, each student should submit a report and deliver an oral presentation.

Teaching and Learning Methods / Activities

- There are no mandatory formal teaching arrangements for this module: however it is normally expected that industry will provide appropriate training as may be required to support the student during their work.

Evaluation

Final Industrial Report	40 %
Oral Presentation	20 %
Evaluation Report from the Industrial Supervisor	20 %
Training Log Records	20 %

Recommended References

- Marcus, A., Thrower, R.J., and Cengage, D. (1985). Introduction to Applied Physics.
- Manjeet, S., Deepak, T., and Hardeep, K. (2016). Applied Physics Vayu Education of India.
- Desoer, S. (2009). Training Manual for Industrial Training Institutes Part I. 3rd ed. Mc Graw Hill India.
- Dge, T. (2002). Training Manual for Industrial Training Institutes and Centres. McGraw Hill Education (India) Private Limited.