PROGRAM COURSES WITH COURSE LEARNING OUTCOMES	PROGRAM LEARNING OUTCOMES												
	PLO#1	PLO#2	PLO#3	PLO#4	PLO#5	PLO#6	PLO#7	PLO#8	PLO#9	PLO#10	PLO#11	PLO#12	PLO#13
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For each CLO, the PLO(s) it satisfies are indicated, and at which level. The three levels are:													
Introduced [I]: Course learning outcomes that concentrate on knowledge or skills related to the program outcomes at a basic level or skills at an entry-level of complexity.													
Developing [D]: Course level outcomes that demonstrate learning at an increasing level of proficiency of the program level outcome as well expanding complexity.													
Advanced [A]: Course level outcomes that demonstrate learning related to the program level outcome with an increasing level of independence, expertise and sophistication or integrate the use of content or skills in multiple levels of													
PHYS 1101	I	I		I	I		I		I	I	I		I
Explain the concepts of vectors and their use in mechanics problems	I	I		I	I								I
Apply Newton's laws of motion to point particles as well as extended objects	I	I		I	I								I
Apply the concepts of work and energy to mechanics problems	I	I		I	I								I
Apply the conservation laws to systems of particles	I	I		I	I								I
Explain the basic concepts in simple harmonic motion, waves, sound, fluids and heat	I	I		I	I								I
Use computers in the laboratory for the collection and analysis of data and in the presentation of results	I	I			I		I		I	I	I		I
PHYS 1102	I	I		I	I		I		I	I	I		I
Explain the concepts of currents, charges and electric fields in electrostatic and circuit problems	I	I		I	I								I
Explain the concepts involving moving charges in magnetic fields	I	I		I	I								I
Solve simple problems in finding magnetic fields produced by moving charges	I	I		I	I								I
Explain electromagnetic induction	I	I		I	I								I
Solve both geometric and physical optics problems	I	I		I	I								I
Explain some of the basic concepts of nuclear physics and radioactivity	I	I		I	I								I
Use computers in the laboratory for the collection and analysis of data and in the presentation of results	I	I			I		I		I	I	I		I
Discuss applications of course topics to the life sciences	I	I		I	I								I
PHYS 1120	I	I			I		I		I	I	I		I
Explain the concepts of vectors and their use in mechanics problems	I	I			I								I
Apply Newton's laws of motion to point particles as well as extended objects	I	I			I								I
Apply the concepts of Work and Energy to mechanics problems	I	I			I								I
Apply the conservation laws to systems of particles	I	I			I								I
Explain the basic concepts of oscillatory motion, waves, and sound	I	I			I								I
Use computers in the laboratory for the collection and analysis of data and in the presentation of results	I	I			I		I		I	I	I		I
PHYS 1220	I	I		I	I		I		I	I	I		I

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Use computers in the laboratory for the collection and analysis of data and in the presentation of results	I	I			I		I		I	I	I		I
PHYS 1600	**I**				**I**		**I**	**I**		**I**			**I**
Write computer programs in the C programming language													
Construct simple circuits on a breadboard, based on a microcontroller and Input/Output (IO) devices such as push-button switches and Light Emitting Diodes (LEDs)	I						I	I		I			I
Write simple programs in C to enable a microcontroller to receive and analyze input data	I						I	I		I			I
Use measured data to control output	I						I	I		I			I
Use and maintain a proper notebook													
Function effectively in a group environment													
Produce written and oral presentations on group project(s)	I				I								I
PHYS 2010	D	D	I		D					D			D
State the assumptions made by Einstein which led to the Special Theory of Relativity	D	D											D
State important implications of the theory of special relativity	D	D											D
Perform Lorentz transformation of space-time coordinates under special relativity	D	D											D
Describe the invariants in special relativity and apply them in problem solving	D	D											D
Summarize the historical development of the theory of Quantum Mechanics	D	D			D								D
Recognize the evidence for quantization in nature	D												D
State the Schrödinger Equation, describe its significance, apply to simple problems	D	D								D			D
Solve the Schrödinger Equation for a variety of simple potential functions	D	D											D
State the Uncertainty Principle and its applications	D												D
Describe simple crystal structures	D		I										D
State the principles of band theory and apply to simple problems	D												D
Perform simple calculations involving the electronic properties of solids	D	D											D
Understand the basic properties and operation of	D	D											D
PHYS 2030	D	D			I/D				I	I			I/D
Solve dynamics problems involving time, space and velocity dependent forces using elementary calculus	D	D			I/D				I	I			I or D
Show that a given equation of motion satisfies a given differential equation	I	I			I/D				I	I			I or D
Solve the harmonic oscillator problem including the damped and forced cases	D	D			I/D								I or D

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Recognize the importance of dimensional analysis in the study of fluids and state several dimensionless ratios of interest such as Euler's number and Reynolds' number	D	D			I/D								I or D
PHYS 2040	D	I			I		I	I/D	I	D			I
State the 4 laws of thermodynamics	D	I			I				I				
Describe the operating principles of common thermometers	D				I		D	D	D				
Name standard themodynamic processes (isothermal,adiabatic, etc)	D				I				I				
Analyze common thermodynamic cycles for ideal gases in the pV plane	D	I			I		I		I	D			
State several versions of the Second Law	D	I			I				I				
Describe several ‘real world’ heat engines	D				I		I						I
Define entropy macroscopically and statistically	D	I			I				I				
Define thermodynamic potentials: Enthalpy, Free Energy	D	I			I				I				
Describe Planck’s resolution of the ultraviolet catastrophe	D	I			I			I	I				
Perform calculations using the Stefan Boltzmann radiation law	D	I			I				I	D			
Apply thermodynamic principles to modern energy technologies such as solar panels and heat pumps	D				I		I						
PHYS 2100	D	D			D		D	I/D	D	D	D	D	D
Describe the characteristics of, and demonstrate the operation of, common laboratory equipment such as oscilloscopes and function generators	D	D			D		D	I & D	D		D	D	D
Apply physical principles in designing, and choosing instrumentation for, physics experimentsUse electronic instrumentation as well as computers to acquire experimental data in physics experiments	D	D			D		D	I & D	D	D	D	D	D
Organize and interpret experimental data in physics experiments	D	D			D		D	I & D	D	D	D		D
Use theoretical methods and computer software to analyze experimental data in physics experiments	D	D			D		D	I & D	D	D	D	D	D
Write a formal laboratory report on physics experiments	D	D			D		D	I & D	D	D	D		D
PHYS 2420	D	D			D							I	D
Calculate electric field and electric potential for various charge distributions, incorporating the effects of dielectrics	D	D			D							I	D
Calculate magnetic fields for various current distributions, with or without the presence of matter	D	D			D							I	D
Calculate induced emfs	D	D			D							I	D
Solve DC and AC circuit problems with standard circuit elements, using phasor and complex number representation where appropriate													

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Use a microcontroller unit to measure voltages and currents in AC and DC circuits	D	D					D		D	D			D
Troubleshoot circuits that are not performing as expected	D	D					D	I	D			I	D
Work with common laboratory tools such as function generators, oscilloscopes, and power supplies	D	D					D	I		D			D
Record data using a computer spreadsheet (e.g.MS Excel)									D	D			
Write and present reports	D	D			D				D			I	D
Program in C					D					D			D
PHYS 2610	D	D	I				D	D	D	D			D
Choose an appropriate sensor and/or actuator for a particular measurement	D	D	I				D						D
Test and calibrate sensors and actuators	D	D					D	D	D	D			D
Convert sensor output to physical quantities, e.g. convert a thermistor voltage to temperature in degrees Celsius	D	D							D	D			D
Interface a microcontroller unit (MCU) to a sensor and/or actuator and write a C program for the operation of the MCU										D			D
Interface a data acquisition module to a sensor and/or actuator and write a LabVIEW program for the operation of the module										D			D
Collect data using a computer spreadsheet (e.g. MS Excel) and use symbolic math programs (e.g. MAPLE) to aid in converting data	D	D					D			D			D
PHYS 3610	D	D	I		I/D		I/D	I/D	I/D	I/D	D		I/D
Model physical systems in the time and frequency domain	D	D			I/D				I/D				I/D
Analyze the response of first and second order systems	D	D			I/D				I/D				I/D
Obtain the transfer function of linear systems		D			I/D				I/D				I/D
Model linear systems using block diagrams	I/D		I		I/D				I/D	I/D			I/D
Design on-off controls systems with PLCs			I		I/D		I/D	I/D	I/D	I/D	D		I/D
Use software such as Matlab to model linear systems and to design classic control systems					I/D		I/D	I/D		I/D			I/D
Create basic programs in Ladder Logic to control industrial processes					I/D		I/D	I/D		I/D	D		I/D
Create logic circuits using pneumatic and hydraulic components and simulators					I/D		I/D	I/D			D		I/D
Read electrical, pneumatic and hydraulic schematics					I/D		I/D	I/D					I/D
PHYS 3620	I/D	I/D	I		I/D		D	I/D	I/D	D	D		I/D
Design feedback control systems using the root locus, frequency response and state space techniques	I/D		I		I/D			I/D	I/D	I/D			I/D
Use software such as Matlab to plot the root locus, Nyquist and Bode diagrams		I/D	I		I/D			I/D	I/D	I/D			I/D
Use software such as Matlab to simulate feedback control systems using block diagrams		I/D	I		I/D			I/D	I/D	I/D			I/D

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PHYS 3700	A	A							A	A			A
Understand and explain the concepts and methods of signal and image processing	A	A							A	A			A
Sample signals effectively and reconstruct signals from samples	A	A							A	A			A
Design and implement digital filters	A	A							A	A			A
Use Fourier transform techniques for signal and image analysis	A	A							A	A			A
Critically assess the appropriateness, reliability, and limitations of various signal and image processing techniques for particular applications	A	A							A	A			A
PHYS 3710	A	A/D					A	A	A	D	D	D	A
Design, construct and analyze optical systems for imaging, illumination, sensing/testing, communications and other applications.	A	A					A	A	A	D	D	D	A
Select, prepare and work with common optical components such as lenses, mirrors, filters, optical fibers.	D	D					A	A	A	D	D	A	A
Confidently use and understand common optical devices such as microscopes, telescopes, interferometric devices and spectrometers.	A	A					A	A	A	D	D	D	A
Understand the operation and applications of a variety of light sources.	A	D					A	A	A	D	D	D	A
Understand the ray, wave and photon models of light and recognize their domains of applicability.	A	A					A	A	A	D	D	D	A
Work safely with lasers.	D						A	A				D	
PHYS 3900	D	D			D	D	D	D	D	D	D	D	D
Perform and present a literature review on the topic of the project	D	D			D	D						D	D
Choose parameters to be measured and/or controlled, instruments/methods to be used, calibration procedures and appropriate techniques for analysis of measurement data and uncertainties	D	D					D	D	D	D			D
Apply knowledge and skills from their coursework to the project	D	D					D	D	D	D		D	D
Identify and address gaps in their knowledge and skills as relevant to the project	D	D						D				D	D
Use appropriate statistical methods and computer software for data analysis	D	D					D	D	D	D			D
Work with less supervision than in laboratory activities in previous courses	D				D		D				D	D	D
PHYS 3950	D	D			D	I	D		D	D	D	D	D
Identify goals and objectives for their work term					D						D	D	D
Apply knowledge and skills from their studies to their work at		D	Some		D		D		D	D (many	D		

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Understand workplace etiquette and norms					I						I		
Identify and assess gaps in their knowledge and skills as relevant to the work being carried out												D	
Respond constructively to feedback from the host organization and from the Physics work experience committee					D						D	D	
Write a report that includes an assessment of progress in meeting the initial goals, a description of the work being carried out, and a plan for the second part of the work term	D	D			D				D			D	D
PHYS 3951	A	D			D	D			A		D/A	A	D/A
Identify goals and objectives for the remainder of the work term					A						A	A	D
Identify the relevance of their studies to the work being done by their host organization	A	A			D	D	A (many students)		A (many students)	A (many students)			D
Identify additional knowledge and skills learned so far during the work experience	D	D			D								
Identify and assess gaps in their knowledge and skills as relevant to the work being carried out					D							A	
Formulate a plan for acquiring additional knowledge and skills during the remainder of the work term					D						A	A	A
Respond constructively to feedback from the host organization and from the Physics work experience committee					D						A		
Appreciate the rigours and demands of the modern workplace					D						D		
Understand workplace etiquette and norms					D						D		
Write a final report that includes a self-assessment and a description of the work that was performed	A	D			A				A			A	A
Make a presentation on the placement to physics faculty and students	A	D			A								A
PHYS 4010	A	A			A					A			A
Calculate measurement probabilities for states with a finite number of outcomes (e.g. spin = n/2 systems)	A	A											A
Use bra-ket formulation in calculations	A	A											A
Normalize state vectors	A	A											A
Determine if two operators are compatible	A	A											A
Solve the characteristic equation for a state with n outcomes and determine the eigenvectors and eigenvalues	A	A								A			A
Explain how interference effects arise in quantum systems	A	A											A
Sketch physically reasonable wavefunctions for 1D potential wells and barriers	A	A								A			A
Numerically determine energy levels of 1D potential wells	A	A								A			A

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Develop a project schedule with milestones	A				A	A							A
Organize materials and equipment required for the project	A						A	A	A	A		A	A
Maintain effective communication with the project supervisor (and industry representative as applicable)	A	A			A	D		A			A		A
Present the full proposal in both written and oral formats	A				A	D		A					A
PHYS 4299	A	A			A	D	A	A	A	A	A	A	A
Conduct the project proposal developed in PHYS 4199	A	A					A	A	A	A		A	A
Maintain a project notebook					A		A						
Troubleshoot and solve problems that may arise during the course of the project	A						A	A	A			A	A
Apply appropriate statistical methods and computer software for data analysis		A						A	A	A			A
Maintain effective communications with the project supervisor (and industry representative if applicable)	A	A			A	D		A			A		A
PHYS 4600	A	A			A	D	A			A	A	A	A
Write effective programs in industrially relevant programming languages to interface with instrumentation		A					A			A		A	A
Analyze and debug programs							A			A			
Interface a variety of hardware devices with computer systems	A						A			A		A	A
Conduct research to select and specify appropriate hardware and software for industrial applications	A	A					A			A		A	A
Explain the limitations and abilities of different prorgramming techniques	A	A				D	A			A		A	
Work in development teams producing human-readable well commented and documented code	A				A	D				A	A		
Describe the software development process in terms of prototyping, testing and profiling code						D	A			A			
Recognize and work with a variety of programming languages						D	A			A			A
Apply industry standards for software and hardware interfaces						A	A			A			
PHYS 4700	A	A			A		A		A	A	A	D	A
Predict and recognise the features of diffraction patterns from various crystal structures	A	A											A
Use band theory to explain the differences between insulators, semiconductors, and metals	A	A			A								A
Use spectroscopic techniques to probe the band structure of various materials													
Explain, and perform calculations pertaining to the properties of semiconductors, metals, superconductors, and magnetic materials	A	A			A								A
Describe important experimental techniques used by solid state	A	A			A								A

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PHYS 4900													
Describe the foundational physics of the problem of interest													
Describe the basics of the technology applicable to the topic													
Identify the application of this topic in BC , Canada, North America, and around the world													
Communicate the importance of the topic orally and in writing													
BIOL 1110	I	I	I	I	I	I	I	I	I	I	I		I
Describe the current system of biological taxonomy and explain why it is changing				I	I								
Describe the key features of major groups of organisms					I								
Explain how organisms have evolved by natural selection					I								
Describe and explain nutrient cycling and energy flow in ecosystems	I	I	I	I	I				I				I
Recognize and differentiate a range of interspecific interactions in communities					I								
Relate the structure of plant tissues to their functions					I								
Compare and contrast a range of morphological and physiological systems in selected organisms	I		I	I	I								
Carry out basic laboratory procedures, including the use of compound and dissecting microscopes, preparation of material for observation with a microscope, and construction of biological drawings	I	I		I			I				I		
Apply the scientific method to conduct and report on experimental investigations		I			I		I	I	I	I	I		I
Cooperate with group members to complete tasks in a shared learning environment					I			I			I		I
CHEM 1110	I	I	I	I	I		I		I				I
Solve a variety of stoichiometric and gas law problems	I	I	I				I		I				I
Solve problems based on the Bohr model of the atom, other 1-electron atomic systems and the photoelectric effect	I	I	I				I						I
Use quantum theory to discuss orbital shapes, energies and electron configurations of atoms and ions	I	I	I		I								I
Describe and explain trends in atomic and ionic radii, ionization energies, electron affinities, and electronegativities with reference to the Periodic Table of Elements	I	I	I		I								I
Describe ionic and covalent bonding and explain trends in physical properties based on type of bonding		I	I	I	I								I
Use Lewis structures and resonance to describe bonding and													

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Name a variety of organic compounds containing different functional groups			I	I			I						I
Describe and illustrate different types of isomerism possible in organic compounds			I	I	I		I						I
Predict the products of simple reactions involving organic compounds			I	I			I						I
Discuss the common types of radioactivity and their uses	I		I		I								I
Solve problems based on the rates of radioactive decay, binding energies of nuclei and energy associated with nuclear reactions	I	I	I										I
CHEM 1210	I	I	I		I		I		I				I
Solve problems in electrochemistry, chemical kinetics, thermodynamics, equilibria involving gases, acids and bases, ionic compounds, liquids and solids, solutions	I	I	I		I				I				I
Write reports based on observations and data obtained in the laboratory for each of the experiments performed			I		I		I		I				I
Perform lab techniques learned throughout the semester by successfully performing experiments as well as a final practical lab exam			I				I		I				I
CHEM 2315		D	D		D		D		D	I			D
Solve problems related to course content		D	D							I			D
Analyze data and write reports based on experiments performed in the laboratory		D	D		D				D	I			D
Perform lab techniques learned throughout the semester			D				D						D
Quantitatively analyze an unknown sample, using techniques learned in class			D				D						D
Report results in a meaningful and useful format			D		D		D			I			D
Use laboratory equipment and instrumentation in a safe and effective manner			D				D						D
CHEM 4610			D		D		D	D	D			D	D
Illustrate understanding of the chemical principles underlying instrumental analysis techniques discussed in class			D										
Design, carry out, record and analyze the results of instrumental analysis techniques			A				D		D				
Identify and solve chemical problems and explore new areas of research.			D										D
Use modern library search and retrieval methods to obtain information on a topic, chemical, instrumental analysis technique or related issue			D		D								
Problem solve, think critically and reason analytically			A						D				
Know the proper procedures to safely and skillfully use the instruments in the laboratory, design experiments and properly													

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Understand audience, purpose, and occasion					I								I
Analyze and evaluate structure, logic, style, and evidence					I						I		I
Explore and refine ideas through discussion and debate					I								I
Think and respond critically to a broad range of texts and cultural products					I								I
Engage in a writing process that includes brainstorming, outlining, drafting, and revising strategies to produce university-level writing					I						I		I
Apply principles of unity, development, and coherence in writing					I								I
Produce clear, grammatical, and logical written work independently					I								I
Write essays that assert and support clear thesis statements					I							I	i
Research and assess secondary-source material using university-level methods and resources					I								I
Integrate sources effectively into written work using quotation, paraphrase, and summary					I								I
Document source material and format essays using MLA and/or APA citation methods to uphold the principles of academic integrity					I								I
Recognize and correct errors in their own writing					I							I	I
MATH 1120		I			I					I			I
State and apply the concepts of differential calculus, including the limit, the derivative, both as the slope of a tangent line and as a rate of change, and the geometry of derivatives	I (minimal)	I			I					I (minimal)			I
Compute, in simple cases, derivatives from the definition		I			I								I
Demonstrate and apply the basic skills of calculus (finding limits, differentiation, graphing) for algebraic and elementary transcendental functions		I			I					I (minimal)			I
Apply these skills to solve applied problems		I			D								I
Use a computer algebra system to solve problems related to differential calculus		I			I					I			I
MATH 1130		I		I	I								I
Understand and state the basic concepts of differential calculus		I			I								I
Find limits of, differentiate, and graph algebraic and elementary transcendental functions		I			I								I
Apply the above concepts and skills to the solution of applied problems, especially those of biological sciences		I		I	I								I
MATH 1220		I			I				I	I			I
Understand, state and apply the concepts of integral calculus,													

PROGRAM COURSES WITH COURSE LEARNING OUTCOMES	PROGRAM LEARNING OUTCOMES												
	PLO#1	PLO#2	PLO#3	PLO#4	PLO#5	PLO#6	PLO#7	PLO#8	PLO#9	PLO#10	PLO#11	PLO#12	PLO#13
	Physics Knowledge	Math Knowledge	Chemistry Knowledge	Biology Knowledge	Comm skills	Business	Lab techniques and practical skills	Experimental design skills	Using data to formulate or validate models	Sofware & computer programming	Cooperation and teamwork attitudes	Limits of knowledge & independent learning	Integration of knowledge & skills
MATH 1230		I		I	I								I
Evaluate both definite and indefinite integrals		I			I								I
Solve applied problems requiring integration (area between curves, volume of rotation, probability density functions)		I		I	I						I		I
Solve first order differential equations and analyze them qualitatively		I		I	I				I		I		I
Use calculus to model biological systems		I		I	I				I		I		I
MATH 2721	I	I			D					I			D
Use matrices to solve a variety of problems in physics and engineering	I	I			D					I			D
Apply common matrix algebra algorithms such as inversion and diagonalization		I			D					I			D
Perform basic arithmetic and algebra with complex numbers	I	I			D								D
Use complex numbers in the solution of differential equations relevant to physics and engineering	I	D			D					I			D
MATH 2821	I	D			D								D
Find equations of lines and planes		D			D								D
Recognize the equations of cylinders and quadratic surfaces; use level curves to visualize and sketch surfaces		D			D								D
Evaluate and interpret partial derivatives		D			D								D
Evaluate and interpret gradients and directional derivatives		D			D								D
Evaluate and interpret double and triple integrals	I/D	D			D								D
Evaluate multiple integrals using polar, cylindrical, and spherical coordinates		D			D								D
Calculate area, volume, mass, first and second moments, and center of mass	I/D	D			D								D
Evaluate derivatives of vector-valued functions of a single variable		D			D								D
Evaluate line integrals of scalar and vector functions; work as a line integral	I	D			D								D
Evaluate operators (grad, div, curl, Laplacian) in all three major coordinate systems	I	D			D								D
Evaluate surface integrals of scalar- and vector-valued functions	I	D			D								D
State the Divergence Theorem and apply to electricity and magnetism, and fluid flow		I			I								I
Evaluate line and surface integrals using Green's and Stokes' theorems		D			D								D
Apply the concepts of the course to topics such as electricity and magnetism, and fluid flow	D	D			I/D								D