# Appendix D

# Proposed University of Victoria Bachelor of Software Engineering (BSENG) Degree Program

# Calendar Course Descriptions V6.0—November 8, 2002

## Introduction

This document contains the calendar course descriptions of the proposed University of Victoria *Bachelor of Software Engineering (BSENG)*. To get an overview of the courses, please consult the *BSENG Formal Degree Program Proposal*, the *BSENG overview matrix*, the *BSENG prerequisite structure,* and the *BSENG Calendar Entry*. To gain insight on how the *BSENG curriculum* was developed, please consult the *BSENG Curriculum Executive Summary*.

These course descriptions are a combination of University of Victoria calendar descriptions (i.e., SENG, CSC, CENG, and ELEC), IEEE/ACM Computing Curricula 2001 descriptions (i.e., Steelman Draft, August 1, 2001), revised course descriptions, and new course descriptions.

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**MCOM: Mobile Communications**
**AOOD : Advanced Object Oriented Design**
**SP : Software Process**
**MSD : Management of Software Development**
**TOP : Topics in Software Engineering**

# Calendar Course Descriptions

## Required Courses

**SE 1: Object-Oriented Programming**
Introduces the fundamental concepts sequential and object-oriented programming. Through the study of object design, this course also introduces the basics of human-computer interfaces, and the social implications of computing, along with significant coverage of software engineering.
*Prerequisites:* none

**SE 2: Object-Oriented Design and Methodology**
Continues the introduction to object-oriented programming begun in SE 1, with an emphasis on algorithms, data structures, software engineering, and the social context of computing.
*Prerequisites:* SE1, LA

**SE 3: Software Architecture and Development Methods**
Provides an introduction to software architecture and development methods including aspects of object-oriented analysis, design and development to create medium-scale applications. Topics include software architecture and components, object-oriented design and metrics, component integration, interfaces, component libraries and reuse, exception handling, serialization, testing, and project management.
*Prerequisites:* SE2, WE

**SE 4: Systems Programming and Middleware**
Provides an introduction to systems and middleware programming using programming and scripting languages. Topics include interacting with the various components of an operating system, end-user programmable tools, and the Web. Control, data, and presentation integration mechanisms as well. Web interoperability through Web standards, protocols, and services.
*Prerequisites:* SE3, CAS

**SE 5: Requirements Engineering and Formal Specification**
Combines a range of topics integral to the design, implementation, and testing of a medium-scale software system with the practical experience of implementing such a project as a member of a programmer team. Introduces formal methods, requirements engineering, specifications, software life cycle models.
*Prerequisites:* ALG1, SE4, DS2 or ALG1, CENG 245, registration in CENG

**SE 6: Software Evolution**
Introduces problems and solutions of long-term software maintenance/evolution and large-scale, long-lived software systems. Topics include software engineering techniques for programming-in-the-large, programming-in-the-many, legacy software systems, software architecture, software evolution, software maintenance, reverse engineering, program understanding, software visualization, advanced issues in object-oriented programming, design patterns, antipatterns, and client-server computing. This course culminates in a team project.
*Prerequisites:* SE5

**SE 7: Embedded Systems**
Characteristics and design of embedded systems. Formal models and specification languages for capturing system behaviour. Techniques for specification, exploration and refinement. System partitioning and hardware/software co-design. Tools for validation, verification, and simulation. Quality and performance metrics. Embedded real-time systems are pervasive in today's world (e.g., telecommunications systems, consumer electronic products, automotive systems, and aerospace systems).
*Prerequisites:* SE6

**SE 8: Software Quality Engineering**
This course emphasizes software quality engineering as an integral facet of development, from requirements through delivery and maintenance. The students will learn how to choose appropriate quality goals and select, plan, and execute quality assurance activities throughout development and evolution to predictably meet quality and schedule goals. They will learn how quality assurance can be incorporated into process improvement feedback loops that amplify the ability of an organization to cost-effectively prevent and detect faults.
*Prerequisites:* SE6

**CAP: Capstone Project**
Offers students the opportunity to integrate their knowledge of the undergraduate software engineering curriculum in a significant design experience which is based on the knowledge and skills acquired in earlier course work.
*Prerequisites:* SE6

**MECHSYS: Mechanical Systems for Engineers**
Introduce engineering students to systems built by mechanical engineers and modes of thinking used by these engineers through the teaching of selected subjects with lectures by faculty and invited speakers from industry, films, and laboratory demonstrations. As an introductory course students will be exposed to fundamentals of engineering design, engineering ethics, problem solving methods demanding the application of fundamental engineering principles and checking of solutions. Introduce students to the terminology, mathematics, and methods used in mechanical engineering. The lectures also discuss career opportunities in mechanical engineering and related fields, emerging technologies, and the cross-disciplinary nature of engineering. The course features a significant project. Motivating engineering students is a key aspect of this course.
*Prerequisites:* none

**ELECSYS: Electrical Systems for Engineers**
Introduce engineering students to systems built by electrical and computer engineers and modes of thinking used by these engineers through the teaching of selected subjects with lectures by faculty and invited speakers from industry, films, and laboratory demonstrations. As an introductory course students will be exposed to fundamentals of engineering design, engineering ethics, problem solving methods demanding the application of fundamental engineering principles and checking of solutions. Introduce students to the terminology, mathematics, and methods used in electrical engineering. The lectures also discuss career opportunities in electrical engineering and related fields, emerging technologies, and the cross-disciplinary nature of engineering. The course features a significant project. Motivating engineering students is a key aspect of this course.
*Prerequisites:* PHYS

**DS 1: Discrete Structures 1**
Introduces the foundations of discrete mathematics as they apply to computer science, focusing on providing a solid theoretical foundation for further work. Topics include functions, relations, sets, simple proof techniques, Boolean algebra, propositional logic, digital logic, elementary number theory, and the fundamentals of counting.
*Prerequisites:* CALC1

**DS 2: Discrete Structures 2**
Continues the discussion of discrete mathematics introduced in DS 1. Topics in the second course include predicate logic, recurrence relations, graphs, trees, matrices, computational complexity, elementary computability, and discrete probability.
*Prerequisites:* DS1

**CAS: Computer Architecture and Assembler Programming**
Introduces students to the organization and architecture of computer systems, beginning with the standard von Neumann model and then moving forward to more recent archictural concepts.
*Prerequisites:* SE2

**ALG 1: Algorithms and Data Structures**
Introduces formal techniques to support the design and analysis of algorithms, focusing on both the underlying mathematical theory and practical considerations of efficiency. Topics include asymptotic complexity bounds, techniques of analysis, algorithmic strategies, and an introduction to automata theory and its application to language translation.
*Prerequisites:* SE2, DS1

**DD: Digital Design**
This course develops a structured design methodology for the design of complex digital systems. This is achieved by using a systems level approach to the development of a digital design. An introduction to the use of suitable CAD tools is given in the laboratories whilst covering the more theoretical aspects associated with logic design in the lectures.
*Prerequisites:* CAS

**AFL: Automata Theory and Formal Languages**
A survey of formal models and results that form the theoretical foundations of computer science; typical topics include regular and context-free languages, finite automata, Chomsky hierarchy, Turing machines, undecidable problems, and computational complexity.
*Prerequisites:* ALG1, DS2

**LA: Linear Algebra**
Complex numbers; matrices and basic matrix operations; vectors; linear equations; determinants; eigenvalues and eigenvectors; linear dependence and independence; orthogonality.
*Prerequisites:* none

**WE: Web Engineering**
Introduces students to the world of computing and communications through the World-Wide Web. SE 1 programming background is required, students will learn some programming through scripting languages. Topics include security, privacy, history, multimedia technologies, HCI, network management, electronic commerce.
*Prerequisites:* LA

**PS: Introduction to Probability and Statistics**
Descriptive statistics; elementary probability theory; random variables, discrete and continuous probability distributions, expectation, joint, marginal and conditional distributions; linear functions of random variables; random sampling and sampling distributions; point and interval estimation; classical hypothesis testing and significance testing. The mathematical foundations of statistical inference will be introduced and illustrated with examples from a variety of disciplines.
*Prerequisites:* none

**HCI: Human-Computer Interaction**
Presents a comprehensive introduction to the principles and techniques of human-computer interaction.
*Prerequisites:* PS, SE3

**OSDC: Operating Systems and Distributed Computing**
Introduces the fundamentals of operating systems together with the basics of networking and communications.
*Prerequisites:* ALG1, SE4 or ALG1 and third-year standing in CENG

**DB: Databases**
Introduces the concepts and techniques of database systems.An introduction to the use and operating principles of database management systems. Topics to be covered include: data entities and relationships; data modeling using Entity-Relation Diagrams: hierarchical, network and relational models of databases; query languages; physical representation of data in secondary storage; relational algebra and calculus as applied to the design of databases; security and integrity in the context of concurrent use; and basic ethical issues associated with database design and use.
*Prerequisites:* OSDC, SE4

**NET: Networks**
Introduces the structure, implementation, and theoretical underpinnings of computer networking and the applications that have been enabled by that technology.
*Prerequisites:* OSDC, SEC

**RT: Real-time Systems**
Fundamental issues in design of real-time operating systems and application software. Typical topics include: hard real-time scheduling, interrupt driven systems, process communication and synchronization, language requirements for real-time systems, decomposition of real-time requirements into process models, and case studies. A project involving design, implementation and testing of a real-time executive and real-time application software will also be included.
*Prerequisites:* SE7

**CALC1: Calculus 1**
Review of analytic geometry; functions and graphs; limits; derivatives; techniques and applications of differentiation; antiderivatives; the definite integral and area; logarithmic and exponential functions; trigonometric functions; Newton's, Simpson's and trapezoidal methods.
*Prerequisites:* none

**CALC2: Calculus 2**
Volumes; arc length and surface area; techniques of integration with applications; polar coordinates and area; l'Hospital's rule; Taylor's formula; improper integrals; series and tests for convergence; power series and Taylor series; complex numbers.
*Prerequisites:* CALC1

**SYSDYN: System Dynamics**
System definition and properties. Continuous and discrete systems. Linearity, causality, determinism, equivalence. Modeling of linear time-invariant systems using differential and difference equations with applications. Solutions of differential and difference equations. Laplace transforms and the representation of signals and systems.
Transfer functions and block diagrams. Fourier transforms and Fourier series in spectral analysis. Interrelation between the Fourier and Laplace transforms. Extensive use of MATLAB including simulation of engineering systems and applications.
*Prerequisites:* CALC2

**SAS: Signal and Systems**
Continuous time signals and waveform calculations. The Fourier series in the analysis of periodic signals. The impulse and other elementary functions. Resolution of signals into impulse and unit step functions. The Fourier transform in spectral analysis. Functions of a complex variable. Analytic functions. Partial fractions. The Laplace transform in the representation of signals. Interrelation between the Fourier and Laplace transforms. Design project using Matlab.
*Prerequisites:* SYSDYN, ELECSYS

**CTRL: Control Systems**
To introduce the basics of design and analysis of control systems. Principles of control: block diagrams, transfer functions, open and closed loop systems, linear-time invariant systems, Bode Plot and Nichols' Chart. Performance specification and estimation: stability criterion, Routh-Hurwitz and Nyquist stability criteria; root locus methods; steady state errors, transient performance. Simple design methods. Discrete systems: Z-transform, stability criterion, discrete continuous equivalence, sampling interval considerations. Automation: the design process, design specification, technological alternatives, economics, sensor systems, actuation systems, interfacing, signal conditioning, DC servos, Proportional-Integral-Derivative (PID) controllers; lead and lag compensators; robust design. Microprocessor based control systems. Product design. Aspects of robot system design.
*Prerequisites:* SYSDYN

**SEC: Security Engineering**
This course presents the fundamentals of contemporary computer security and cryptology. Topics included an overview of computer security, protection, disaster planning, and recovery. Risk analysis and security plans. Basics of cryptography. Public key cryptography and protocols. Security models, kernel design and systems testing. Database, network and Web security. The course discusses applications which need various combinations of confidentiality, availability, integrity and covertness properties; mechanisms to incorporate these properties in systems. The course also deals with policy and legal issues.
*Prerequisites:* OSDC, SE5

**BUS1: Engineering Economics and Entrepreneurship**
Macroeconomic principles: money, interest rates, growth. Microeconomic principles: demand and supply, production, consumer utility and elasticity. Net present value, equivalence, rate of return. Public vs private sector cost-benefit analysis, externalities, risk and uncertainty. Industry and innovation life cycles. Entrepreneurship: starting and running a business, identifying market need, researching financial viability, and resource requirements (financial, human, technical).
*Prerequisites:* none

**BUS2: Engineering Planning and Management**
An introduction to and overview of finance and accounting for engineering management. Topics include basic accounting concepts and terminology; preparation and interpretation of financial statements; and uses of accounting information for planning, budgeting, decision-making, control, and quality improvement. Price and output decisions. Choosing among alternative inputs and production processes. Evaluating alternative investments, equipment service life, product development, business plan development and marketing.
*Prerequisites:* none

**SOCIAL: Social and Professional Issues**
Introduces students to the social and professional issues that arise in the context of software engineering.
*Prerequisites:* none

# Engineering Electives

**ARCH: Software Architecture**
Architectural design of complex software systems. Commonly-used software system structures, techniques for designing and implementing these structures, models and formal notations for characterizing and reasoning about architectures, tools for generating specific instances of an architecture, and case studies of actual system architectures. The role of standards, reuse, and quality. Skills needed to evaluate the architectures of existing systems and to design new systems in principled ways using well-founded architectural paradigms.
*Prerequisites:* SE5 or SENG 330 or SENG 365 or CSC 365

**CBSE: Component-Based Software Engineering**
Building large-scale and complex software systems from available parts by consistently increasing return on investment and time to market, while assuring high quality and reliability. The course covers advanced topics on software components and component-based software engineering from research and practice.
*Prerequisites:* SE5 or SENG 330 or SENG 365 or CSC 365

**CSCW: Computer-Supported Collaborative Work**
Most of the work that people do requires some degree of coordination and communication with others. Successful designs require: (1) social psychological insight into group processes; (2) computer science insight into mechanisms to organize information, coordinate, share, and communicate, and (3) HCI design insight to achieve successful designs for computer- mediated tools. The course focuses primarily on the first two and examines problems and solutions in group coordination and systems including group decision support, organizational memory, virtual spaces, and collaborative design.
*Prerequisites:* HCI

**FTC: Fault Tolerant Computing**
An introduction to selected issues in fault tolerant computing. Topics include: definitions of reliability, availability, safety, maintainability, testability and dependability; system protection through both hardware and information redundancy; quantitative methods for the evaluation of reliability; the design and test of integrated circuits; software fault tolerance and software testing. The course includes a number of case studies of practical fault tolerant systems.
*Prerequisites:* OSDC, DD

**CG: Computer Graphics**
Offers an introduction to computer graphics, which has become an increasingly important area within computer science. Computer graphics, particularly in association with the multimedia aspects of the World-Wide Web, have opened up exciting new possibilities for the design of human-computer interfaces. The purpose of this course is to investigate the principles, techniques, and tools that have enabled these advances.
*Prerequisites:* LA, ALG1

**MMS: Multimedia Systems**
The influence of technology, especially digital technology, on how we express ourselves, how we communicate with each other, and how we preceive, think about, and interact with our world. The invention and creative use of enabling technologies for understanding and expression by people and machines. Topics include: digital video representations; three-dimensional images; physical interfaces; computational tools and media that help people learn new things in new ways (tele-learning); knowledge representation; machine interpretation of sensory data.
*Prerequisites:* none

**ALG2: Algorithms and Data Structures 2**
This course covers algorithm design and analysis in software engineering. Specific topics include advanced data structures (such as Binomial heaps and Fibonacci Heaps), graph algorithms (such as minimum spanning trees, maximum flow, all-pairs shortest paths, and single-source shortest paths), and advanced design and analysis techniques (such as dynamic programming, greedy algorithms, linear programming, and amortized analysis).
*Prerequisites:* ALG1, DS2

**ALG3: Analysis of Algorithms**
General techniques for designing and analyzing algorithms; an in depth examination of several problems and algorithms with respect to their time and space requirements; advanced data structures; sorting and searching; graph algorithms; backtracking; NP-complete problems; approximation algorithms.
*Prerequisites:* ALG1, AFL, DS2

**CC: Compiler Construction**
Compilation, including: lexical analysis, syntax analysis, semantic routines, code optimization, block structured languages and interpreters. Students will implement a compiler-interpreter for a simple language.
*Prerequisites:* SE4, CFL, ALG1

**CON: Concurrency**
Introduction to the foundations of concurrency theory and the issues of specification and verification of concurrent systems. Topics include: Models of concurrency, such as Petri nets, labeled transition systems, and traces. Specification of concurrent systems/programs in formalisms including process algebras, statecharts, Petri nets and temporal logics. Verification techniques, such as bisimulation and model checking. Case studies involve coordination problems, controller design, communication protocols, hardware and user interface design.
*Prerequisites:* OSDC

**PL: Programming Languages**
The fundamental concepts of imperative, object-oriented, applicative, and logic programming languages.
*Prerequisites:* ALG1, CAS, SE4

**AI: Artificial Intelligence**
Philosophy of artificial intelligence. AI programs and languages, representations and descriptions, exploiting constraints. Rule based and heuristic systems. Applications to engineering.
*Prerequisites:* none

**PATREC: Pattern Recognition**
Parallel and sequential recognition methods. Bayesian decision procedures, perceptrons, statistical and syntactic approaches, recognition grammars. Feature extraction and selection, scene analysis, and optical character recognition.
*Prerequisites:* CTRL

**ROBOT: Robotics**
Structure and specification of robot manipulators. Homogenous transformations. Link description. Manipulator kinematics. Inverse manipulator kinematics. Velocity and static forces in manipulators. An introduction to manipulator dynamics. Linear control of robot motion. Model-based nonlinear control of robot manipulators.
*Prerequisites:* MECHSYS, CTRL

**IKM: Information and Knowledge Management**
Uses the idea of information as a unifying theme to investigate a range of issues in computer science, including database systems, artificial intelligence, human-computer interaction, multimedia system, and data communication.
*Prerequisites:* DB

**NC: Network-Centric Computing**
Presents those aspects of computer architecture that are central to communications and networking.
*Prerequisites:* OSDC, SE6

**DC: Distributed Computing**
Introduces concurrency in the context of distributed systems. The course covers both the abstract principles of concurrent programming and their concrete realization in distributed, network-based systems. Topics include the basic theory of concurrency, hardware and software features to support concurrency, concurrent and distributed algorithms, and middleware.
*Prerequisites:* OSDC, SE6

**WMC: Wireless and Mobile Computing**
This course focuses on the design and implementation of wireless and mobile computing *solutions*. The students study emerging technologies such as Jini, WAP, IEEE802.11, and Bluetooth. Targeted applications include handheld and mobile devices such as the Palm Connected Organizer, Handspring Visor, and PocketPC/WindowsCE devices such as the Compaq iPaq and HP Jornada.
*Prerequisites:* SAS

**DSP: Digital Signal Processing**
Generation of discrete-time signals through the sampling process and their spectral representation. Mathematical representation and properties of digital signal processing (DSP) systems. Typical DSP systems: digital filters and applications. The z-transform and its relation to the Laurent series. Evaluation of the inverse z-transform using complex series and contour integrals. Application of the z-transform for the representation and analysis of DSP systems. The processing of continuous-time signals using DSP systems. The discrete-Fourier transform and the use of fast Fourier transforms for its evaluation. Introduction to the design of DSP systems. Design project using Matlab.
*Prerequisites:* SAS

**COM: Digital Communications**
The course is concerned with the transmission, communication and processing of signals (information) and the necessary technical equipment for these purposes. Introduction to protocol engineering; PDU encoders and decoders; buffer management in communications programs; real-time constrains; timer management. Land and satellite-based mobile radio services, systems and networks. Mobile cellular telephone, paging, telepoint and wireless LAN systems. Switching and other protocols in support of mobility. Frequency reuse and channel allocation. Multiple access methods. Architectures of mobile distributed computing systems. Future developments in mobile telecommunications and associated new design problems. Communication via optical fibres.
*Prerequisites:* SAS, CTRL

**NUM: Numerical Methods**
The study of computational methods for solving problems in linear algebra, nonlinear equations, approximation, and ordinary differential equations. The student will write programs in a suitable high level language to solve problems in some of the areas listed above but the course will also teach the student how to use mathematical subroutine packages currently available in computer libraries.
Prerequisites: CALC2

**NA1: Numerical Analysis I**
An introduction to selected topics in Numerical Analysis. Typical areas covered: error analysis, roots of equations, systems of linear equations, linear programming, interpolation, numerical integration, and ordinary differential equations.
*Prerequisites:* SYSDYN

**NA2: Numerical Analysis II**
An introduction to selected topics in Numerical Analysis. Typical areas covered: ordinary differential equations, numerical differentiation, approximation of functions, iterative methods for linear equations, eigenvalues and eigenvectors, systems of nonlinear equations, boundary-value problems and partial differential equations.
*Prerequisites:* SYSDYN

**ORLP: Operations Research: Linear Programming**
An introduction to linear programming and its applications. Topics include: the simplex method, the revised simplex method, computer implementations, duality. Optional topics include: parametric and sensitivity analysis, primal-dual algorithm, network simplex method, the network flow problem, and game theory. Typical applications include: fitting curves to data, the transportation problem, inventory problems and blending problems.
*Prerequisites:* CALC2

**ORSIM: Operations Research: Simulation**
An introduction to discrete event simulation. Topics include: elementary queueing theory, basic techniques of discrete event simulation, generating random numbers, sampling from non-uniform distributions, simulation programming using general purpose languages and also special purpose simulation languages.
*Prerequisites:* CALC2

**MIN: Data Mining**
An introduction to data mining in the context of customer relationship management. Data preparation, model building, and data mining techniques such as clustering, decision trees and neural networks will be discussed and applied to case studies. Data-mining software tools will be reviewed and compared.
*Prerequisites:* DB

**MIRCO: Microprocessor Systems**
Introduction to microprocessor architecture. Instruction sets, addressing modes, and programming. Memories, I/O systems, and interfacing. Development systems. Application to engineering systems.
*Prerequisites:* CAS

**CSA: Computer Systems and Architecture**
Architecture and performance of modern processors, performance metrics; instruction set architectures and their impact on performance; instruction and arithmetic pipelines; pipeline hazards; exception handling; caches. Integral to the course is a Project Laboratory. Working in teams, students are expected to design and implement a processor based on a given specification of a simple instruction set. Student's progress is determined through a preliminary design review, a presentation, demonstration of the implementation and a final report.
*Prerequisites:* none

**ERGO: Ergonomics**
Accidents associated with "human error" often reflect the failure to recognize human factors in the design stage. This course reviews sensory, motor, and cognitive performance characteristics and derives human engineering design criteria. Principles of displays, controls and ergonomics are discussed.
*Prerequisites:* none

**MCOM: Mobile Communications**
Fading and shadowing, noise and interference effects; source coding, modulation, error control coding, spread spectrum and multiplexing techniques for mobile communications; capacity estimation and comparative (FDMA/TDMA/CDMA) analysis of PCN and Cellular Systems; capacity estimation for wireless PABX and LAN systems.
*Prerequisites:* SAS

**AOOD: Advanced Object Oriented Design**
Development and use of object-oriented design abstractions, with emphasis on the design of distributed object-oriented systems. Evaluation and selection of appropriate design patterns. Use of components. Distributed component models such as DCOM and CORBA. Use of models in the design of distributed object-oriented applications. Documentation standards such as UML.
*Prerequisites:* SE3

**SP: Software Process**
Software process design, modeling, implementation, management, assessment and improvement as well as other non-process factors that affect software quality. ISO 9001, SEIfs CMM. Group projects involving industry-relevant software process definition and assessment. Individual study of the research literature. ROI (Return on Investment) analysis.
*Prerequisites:* SE5

**MSD: Management of Software Development**
Non-functional requirements elicitation, configuration control, environments, product lines. Version control. Deployment. Time-to-market versus quality tradeoffs. Defect tracking.
*Prerequisites:* SE6

**TOP: Topics in Software Engineering**
The topics in this course depend primarily on the interests of the instructor. Entrance to the course will be restricted to third and fourth year students who meet the prerequisites specified for the topic to be offered. Some topics may require laboratory work as well as lectures.
*Prerequisites:* SE3, SE4