# PECO 3400, Prime Movers & Auxiliaries

Cogeneration
Compressors
Refrigeration
Special Industrial Equipment
Wastewater Treatment
Plant Maintenance & Administration

4 Credits, 3 Weeks

## Instructors

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Sholeh Kazemi
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Gallage Silva
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## Office Hours

9:00 am – 4:00 pm

## Delivery Method(s):

In Person

*Class location:* CC 123
*Contact:* 780-791-4955
*Email:* powerprocess@keyano.ca

| Day | Time | Location |
|---|---|---|
| Mon – Fri | 9:00 am - 12:00 pm<br>1:00 pm – 4:00 pm | CC1 23 |

### Required Resources

- 3rd Class Power Engineering Learning Materials (Edition 3.0), PanGlobal Training Systems

- CSAB51/B52 Academic Extract Pan Global Training System
- 2018 ASME Boiler & Pressure Vessel Code, An International Guide, Academic Abstract American Society of Mechanical Engineering, Volume 1 & Volume 2
- CSA approved safety boots - minimum 6" from sole to top - Required for in-class lab tours, safety training and 200- hour Power Lab course.
- Pen and paper
- Geometry Math Set & 12" or 18" Ruler
- Symbols Template (optional)
- Standard, scientific calculator programmable calculators are not allowed.
- Students attending in-person should have an electronic device that will allow them to access their course material in Moodle.

## Assessment Details and Dates

| Assessment | Weighting | Course Learning Outcome |
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| **Unit Quizzes** | 10% | CLO 1 - 29 |
| **Section Test 7**<br>02nd Dec. 2024 | 20% | **Prime Movers: Steam Turbines**<br>CLO 1 - Impulse and reaction principles; nozzles; blade shapes.<br>CLO 2 - Turbine arrangements: staging and compounding: principles and p-v diagrams for pressure, velocity and pressure-velocity compounding.<br>CLO 3 - Turbine components: purpose, design, operation of the following: casings, disc and drum rotors, dummy pistons, journal and thrust bearings, barring gear, blade and shaft sealing glands, couplings, interceptor valves on reheat turbines.<br>CLO 4 - Explain purpose and arrangements of condensing, bleeder, topping, extraction, cross and tandem compounded turbines.<br>CLO 5 - Turbine governor types; speed-sensitive, pressure-sensitive, nozzle, throttle, bypass; mechanical, mechanical hydraulic, electronic-hydraulic; droop and isochronous operation.<br>CLO 6 - Starting and shutting down condensing and extraction turbines. |

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| | | CLO 7 - Steam turbine condensers: types, air-cooled, water-cooled, Panier style; condenser auxiliaries; condenser operation; feedwater heater system.<br>**Gas Turbines:**<br>CLO 8 - Applications, advantages and disadvantages of gas turbines.<br>CLO 9 - Basic cycle and improvements: open and closed cycles defined, regeneration, dual shaft arrangement, intercooling and reheating, typical gas turbine operating parameters and efficiency, combined steam and gas turbine cycles.<br>CLO 10 - Main gas turbine components: radial and axial compressors, combustor arrangements and operation, turbine rotor designs.<br>CLO 11 - Gas turbine support systems: fuel supply systems; lubrication; barring gear; steam injection; intake and exhaust components.<br>CLO 12 - Supervisory, protective, and control systems.<br>CLO 13 - Starting and stopping procedures and sequences; turbine washing.<br>**Internal Combustion Engines:**<br>CLO 14 - Gasoline engines: spark ignition defined, two-stroke cycle, four-stroke cycle, carburetion; carburetor design and operation, spark ignition components, fuel injection.<br>CLO 15 - Diesel engines: compression ignition defined, two-stroke cycle, four-stroke cycle, scavenging, fuel injection; fuel injectors; purpose and design of the major mechanical/structural components of a diesel engine; starting and maintenance procedures.<br><br>CLO 16 - Engine support systems: fuel systems, lubrication, governing, starting systems and methods, magneto system, |

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| | | cooling systems, supercharging and turbocharging.<br>CLO 17 - Thermodynamic heat engine cycles: explain the Otto, Diesel and Brayton cycles.<br>**Cogeneration:**<br>CLO 18 - Purpose, advantages, components of cogeneration systems.<br>CLO 19 - Simple and combined cycle.<br>CLO 20 - Using gas turbines and internal combustion engines.<br>CLO 21 - Single and dual shaft arrangements.<br>CLO 22 - Control strategies and components.<br>CLO 23 - Environmental considerations.<br>CLO 24 - Heat recovery boilers and water heaters.<br>CLO 25 - Operating procedures.<br>CLO 26 - Typical industrial cogeneration applications. |
| **Section Test 8**<br>12th Dec. 2024 | 20% | **Compressors :**<br>CLO 27 - Theory of Compression: Adiabatic and isothermal compression; pressure volume relationships; compression ratio, capacity, multi-staging; effect of altitude and moisture.<br>CLO 28 - Applications for compression, including air and gas.<br>CLO 29 - Positive Displacement Compressors: design, operating principles - Reciprocating compressors: clearance volume; indicator diagrams; calculations for displacement and volumetric efficiency.<br>CLO 30 - Rotary Compressors: sliding vane, lobe, and screw types (industrial screw type in detail, including control panel).<br>CLO 31 - Dynamic Compressors: Design and operation of centrifugal and axial flow compressors; application as blowers (21.c.ii. Free Piston Compressor has been removed from the syllabus). |

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| | | CLO 32 - Starting and stopping procedures for positive displacement and dynamic compressors.<br>CLO 33 - Compressor Auxiliaries: Intercoolers/aftercoolers; moisture separators.<br>CLO 34 - Compressor control systems and devices: start and stop, variable and constant speed; safety devices.<br>CLO 35 - Lubrication: internal and external.<br>CLO 36 - Compressor installation and piping layouts.<br>CLO 37 - Compressed air system components: Typical system layout; air receivers (wet and dry) fittings and operation; filters.<br>CLO 38 - Describe the basic types of piping, piping connections, supports, and drainage devices used in the industry.<br>CLO 39 - Air dryers: system design, flows, operation; dewpoint monitoring.<br>**Refrigeration:**<br>CLO 40 - Refrigerant classifications, properties, characteristics.<br>CLO 41 - Compression systems: Principle of compression refrigeration; typical system temperatures and pressures for simple refrigeration systems.<br>CLO 42 - Multi-stage systems: 2-stage with duplex compressors; 2-stage with booster compressor; low-temperature multi-stage.<br>CLO 43 - Direct vs. indirect systems.<br>CLO 44 - Typical refrigeration applications.<br>CLO 45 - Absorption system: ammonia absorption system description and operating parameters.<br>CLO 46 - Refrigeration system auxiliaries: System controls: expansion valves, low-side float, high-side float, capillary tube.<br>CLO 47 - Compressor controls: temperature and pressure-actuated.<br>CLO 48 - Condenser cooling water control. |

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| | | CLO 49 - Safety devices and controls: pressure relief devices, high-pressure cut-out, low-pressure lube oil cut-out.<br>CLO 50 - CSA B52 Regulations: overview of the code for the safe operation, installation and repair of refrigeration Equipment.<br>CLO 51 - System Operation: leak testing, charging, purging, troubleshooting (condenser, regulator, refrigerant strength, compressor discharge temperature); effects of moisture in system; effects of oil in the refrigerant; oil removal using oil separators, oil traps, oil still; operating and maintaining brine systems.<br>**Special Industrial Equipment:**<br>CLO 52 - Describe the general applications, designs, components, operation for the following:<br>CLO 53 - Heat exchangers: double pipe designs; shell-and-tube configurations, head designs, reboiler and feedwater heater fittings; plate frame; overhead aerial coolers; aerial steam condensers, including operation and control.<br>CLO 54 - Cooling towers: natural draft, atmospheric, hyperbolic; mechanical draft designs; operation and control.<br>CLO 55 - Fired Heaters: multi-burner vertical designs; burner components and styles; fuel supply and control; interlocks and safety devices; indirect-fired heaters; horizontal designs; start-up and shutdown procedures.<br>**Wastewater Treatment:**<br>CLO 56 - Purpose of WWT; typical wastewater pollutants and systems<br>b. Theory and equipment for specific treatment process:<br>i. removal of suspended solids (screening, floatation, sedimentation);<br>ii. removal of colloidal solids (chemical coagulation, flocculation, clarification). |

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| | | iii. biological treatment (activated sludge, rotating biological contactors, trickling filters)<br>c. Operating parameters, controls and tests: nutrients, BOD, COD, pH, settleability<br>d. Safety in wastewater treatment plants.<br>**Plant Maintenance and Administration:**<br>CLO 57 - Explain the purpose, typical design and administration of the following plant functions:<br>a. Communication and accountability structures<br>b. Scheduled and preventative maintenance programs<br>c. Record keeping; logbooks; logsheets<br>d. Project control; critical path (applied to a complete boiler turnaround, as an example)<br>e. Operating standards and procedures<br>f. Training and development practices; job skill profiles<br>g. Environmental practices and supervision |
| **E4 Final Exam**<br>13th Dec., 2024 | 50 % | CLO 1 - 57 |

## Proposed Course Schedule

| Week & mode of delivery | Topic(s), Activities, Readings | Graded Assessments (%) | Tentative Due Dates |
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| **Week 1**<br>25 Nov – 29 Nov, 2024 | 3B2- 1 to 3B2- 7 | -Chapter unit quizzes | Due before S7 test<br>(02nd Dec 2024) |
| **Week 2**<br>02nd Dec – 06th Dec, 2024 | 3B2- 8 to 3B2- 15 | -Chapter unit quizzes | Due before S8 test<br>(12th Dec 2024) |
| **Week 3**<br>09th Dec – 13th Dec, 2024 | 3B2- 1 to 3B2- 15 | -Exclusive 4 exam 20% (3B2- 1 to 3B2- 15)<br><br>-Chapter unit quizzes | 13th Dec 2024<br><br>Due before E4<br>(13th Dec, 2024) |
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**Please Note:**

- The date and time allotted to each topic are subject to change.
- Students will have access to their Moodle course shells for 15 days following completion of their course.
- Every effort has been made to ensure that the information in this course syllabus is accurate at the time of publication. Keyano College reserves the right to change the course syllabus content if it becomes necessary so that course content remains relevant. Any changes to the course syllabus during the semester will be communicated to students in writing by the instructor in a timely manner. A revised course syllabus will be posted to the LMS.
- A minimum GPA of 1.7 or higher is required for students to remain in good academic standing and progress to the next semester, unless otherwise indicated for a specific program.

## Keyano Performance Requirements and Student Services

**Student Responsibilities**

As a student, it is your responsibility to contact the Office of the Registrar to complete the required forms, including the Withdrawal/Drop Form. All forms are available on the College website. Please refer to the important dates listed in the Academic Schedule in the Keyano College credit calendar and/or on the College website. It is the responsibility of each student to be aware of the guidelines outlined in the Student and Academic Policies.

**Attendance**

The Power Engineering program is considered an extension of the workplace in terms of attendance, punctuality, and conduct.

Classes are scheduled from Monday to Friday 9:00 am – 4:00 pm.

• One hour lunch break from 12pm-1pm.

• Attendance will be taken twice a day.

• Students must personally notify their instructor(s) and the Power Engineering Department via email at powerprocess@keyano.ca if they are unable to attend a scheduled class. It is expected that personal appointments will be made outside of scheduled class hours.

• Instructors do not grant excused absences without notification from health services. All doctors' notes to be submitted directly to healthservices@keyano.ca for assessment.

• It is expected that students will manage their time in accordance with the program schedule, policy and procedures and will attend and be punctual for all classes every day.

**Student Attendance**

Class attendance is helpful for two reasons: First, class attendance maximizes a student's learning experience. Second, attending class is an excellent way to keep informed of matters relating to the course administration (e.g., the timing of assignments and exams). Ultimately, you are responsible for your learning and performance in this course. It is the responsibility of each student to be prepared for all classes. Absent students are responsible for the material covered in those classes, and students must ensure they are ready for their next class, including completing any missed assignments and notes.

**Course Evaluation**

Midterm exams and term work is to be completed at the time/date indicated in your course syllabus. It is the expectation of the College that students make every reasonable effort to complete all course evaluation, including, quizzes, midterms, and exams, as scheduled. In the event of an emergency, rescheduling of exams and/or extensions are only provided at the discretion of the course instructor. Students should contact the instructor as soon as they are able, to notify them of missing an evaluative component. Instructors will use discretion in deciding whether circumstances justify granting a reschedule and/or extension.

Regular term quizzes, midterms, and exams are not eligible for deferral and/or date extension accommodations. Students with accommodations, please refer to Accessibility Services.

Final Exams are subject to deferral processes, please refer to the current Keyano College Credit Calendar.

**Academic Integrity & Misconduct**

Academic integrity requires commitment to the values of honesty, trust, fairness, respect, and responsibility. It is expected that students at Keyano College will adhere to these ethical values in all activities related to learning, teaching, research, and service. Any action that contravenes this standard, including misrepresentation, falsification, or deception, undermines the intention and worth of scholarly work and violates the fundamental academic rights of members of our community.

Academic dishonesty takes many forms:

- Plagiarism or the submission of another person's work as their own,
- The use of unauthorized aids in assignments or examinations (cheating),
- Using Artificial Intelligence (AI) to complete coursework (without instructor approval),
- Collusion or the unauthorized collaboration with others in preparing work,
- The deliberate misrepresentation of qualifications,
- The willful distortion of results or data,
- Substitution in an examination by another person,
- Submitting unchanged work for another assignment, and
- Breach of confidentiality.

In all academic work, the ideas and contributions of others must be appropriately acknowledged and work that is presented as original must be, in fact, original. Using an AI-content generator (such as ChatGPT) to complete coursework without proper attribution or authorization is a form of academic dishonesty. If you are unsure about whether something may be plagiarism or academic dishonesty, please contact your instructor to discuss the issue.

The consequences for academic misconduct range from a verbal reprimand to expulsion from the College. More specific descriptions and details are found in the *Student & Academic Policies* section of the Keyano College credit calendar. It is the responsibility of each student to be aware of the guidelines outlined in the Student Rights, Academic Integrity, and Non-Academic Misconduct Policies.

To ensure your understanding of plagiarism and academic integrity, you are required to complete the online Understanding Academic Integrity tutorial (https://keyano.libwizard.com/f/academic-integrity-tutorial) and submit the certificate of completion to your instructor(s).

**Online Learning**

Technology and internet connectivity will impact your online learning experience. You may be required to watch online videos, take online quizzes, or participate in live online classes. Live/virtual courses will be hosted in Microsoft Teams or Zoom. For all course delivery types, you will access your course outline, course syllabus and course resources on Keyano's learning management system: Moodle (iLearn). Login in using your Keyano username and password. Keyano College operates in a Windows-based environment and having access to the correct tools for online learning is essential.

**Computer System Requirements**

Keyano College software are Windows based.

| **Minimum Requirements and Recommended Upgrades for Windows (preferred system) and Apple devices**<br>These minimum standards are required for a Windows computer/laptop (OS 10 or 11) and a MacIntosh (OS 10.14 or above). |
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| 1. Windows 10 Operating System or above.<br>2. 4 GB of RAM. Recommended upgrade to 8 GB of RAM.<br>3. 10 GB+ available hard drive storage space. Note installing Microsoft Office 365 requires 3 GB of available hard drive space.<br>a. Install the Microsoft Office 365 suite (~3 GB) *****<br>4. Microphone, webcam, and speakers (All modern laptops have these three accessories built-in). However, a headset or earbuds with a microphone is also recommended.<br>5. Windows has built-in anti-virus/malware software. It is essential to install system updates to keep your device secured regularly. |

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| *Microsoft Office 365 is free to Keyano students. |
| Tablets, iPads, and Chromebooks are **not** recommended: They may not be compatible with your programs such as lockdown browsers used for assessments and/or Microsoft Office 365. |

**Computer Software**

Students have access to Microsoft Office 365 and Read & Write for free using Keyano credentials.

See Recommended Technology for more information.

**Recording of Lectures and Intellectual Property**

Students may only record a lecture if explicit permission is provided by the instructor or Accessibility Services. Even if students have permission to record a lecture or lecture materials, students may not share, distribute, or publish any of the lectures or course materials; this includes any recordings, slides, instructor notes, etc., on any platform. Thus, no student is allowed to share, distribute, publish, or sell course-related content without permission. It is important to recognize that the Canadian Copyright Act contains provisions for intellectual property. The Academic Integrity Policy provides additional information on Keyano College's expectations from students as members of the intellectual community.

**ITS Helpdesk**

If you have issues with your student account, you can contact the ITS Helpdesk by emailing its.helpdesk@keyano.ca or calling 780-791-4965.

**Specialized Supports**

Keyano College is committed to Keyano students and their academic success. There is a variety of student support available at Keyano. All student services are available during Keyano business hours: Monday to Friday, 8:30 a.m. to 4:30 p.m. The College is closed on statutory holidays. If you require support outside of regular business hours, please inform the support service team, and they will do their best to accommodate your needs.

**Accessibility Services** provides accommodations for students living with disabilities. Students with documented disabilities or who suspect a disability can register to discuss their current learning barriers and possible accommodations. Students are required to request accommodations for each term. Please note that requesting accommodations is a process and requires time to arrange. Contact the department as soon as you know you may require accommodations to ensure timely implementation. For accessibility supports, adaptive technology, learning strategies and disability-based funding, please register with Accessibility Services by emailing wellness.services@keyano.ca, or visiting www.wellnessxp.net/wellness/, or scanning this qr code below.

**Wellness Services** offers a caring, inclusive, and respectful environment where students can access free group and individual support to meet academic and life challenges. Mental Health Coordinators provide a safe and confidential environment for you to seek help with personal concerns. Our Wellness Navigator offers support with finding basic needs such as housing, financial and nutritional support, and outside referrals when needed. Wellness Services welcomes students to participate in group sessions that address topics including mindfulness and test anxiety throughout the academic year. Individual appointments can be made by emailing wellness.services@keyano.ca, or visiting www.wellnessxp.net/wellness/, or scanning this qr code below.

The **Library** provides students with research, information, and educational technology services and spaces as they engage in their studies. The Library is located at CC-166 or www.keyano.ca/library. Library staff are available to help students online and in person throughout the semester. Librarians offer individual and small group consultations booked using the online Book A Librarian calendar. The library also provides virtual research and subject guides to help you with your studies. Find the guide that supports your course-related research by viewing the complete list of online Subject Guides. To start your research and access citation guides (APA, MLA, Chicago, or IEEE), visit the Research Help page. The library's collections (including print and online materials) are searchable using EDS (EBSCO Discovery Service) on www.keyano.ca/library/find. The library offers a Loanable Technology collection to support students accessing and using technology. For an up-to-date list of technology available for borrowing, visit the library's Loanable Technology webpage. For a detailed list of library resources and services, go to www.keyano.ca/library. For all inquiries, please email askthelibrary@keyano.ca or chat with us online.

The **Academic Success Centre (ASC)** provides free academic support services to registered students, such as tutoring, writing support, facilitated study groups, workshops, and study space. Academic Content Specialists are available in Business, Mathematics, Science, English, Humanities, Power

Engineering, Upgrading/College Prep, and more. Peer Tutors are available to provide peer academic support to students in all college programs, such as Nursing, Business, Education, Environmental Science, among others. Students are encouraged to visit the Academic Success Centre at CC-119 to discuss strategies for academic success. Specialists in the Academic Success Centre also work with students to develop academic success plans, time management skills, study strategies, and homework plans. For additional information, please email Academic.Success@keyano.ca

**Work Integrated Learning (WIL)** is located in the ASC in CC-119. Career Services WIL staff assist students with their program-related WIL and co-op placements, provide resume advice, and support with using the GradLeaders platform. Additionally, they coordinate several career fairs for students throughout the academic year and host coop and resume workshops for students. Students can reach WIL by emailing: WIL@keyano.ca or by visiting them in person.

Course Syllabus Template Version 1.0

**Signatures & Date**

**Name of Instructor:**

**Instructor Signature:** _____Rajiv Parashar_____

**Date:**

**Name of Course Lead:**

**Course Lead Signature:** _____

**Date:**

**Name of Chairperson/Program Manager:**

**Chairperson/Program Manager Signature:** _____

**Date:**