



Curriculum of the 4th Class (PE Syllabus) Part “A”

Syllabus Section#	Outcomes	Objectives
Part “A”		
A.	Applied Mathematics	
	<i>Arithmetical and algebraic calculations, mensuration, plane figures, area, and volumes. S.I. units.</i>	1- <i>Simple arithmetical (fractions, decimals, percentages) and algebraic (equations, transpositions) calculations, mensuration (length, angles), simple plane figures (perimeters, area), and volumes in S.I. units.</i>
B.	Elementary Mechanics and Dynamics	
	<i>Definition and simple calculations used in the mechanics and dynamics.</i>	1- <i>Simple calculations of scalars, vectors, linear velocity, acceleration, forces, moments, equilibrium of systems, friction, stress, strain, pressure, work, power, energy, factor of safety, power transmission, simple machines, velocity ratio, mechanical advantage, and efficiency.</i>
C.	Elementary Thermodynamics	
	<i>Basic principles, laws of thermodynamics, and modes of heat transfer.</i>	1- <i>First and second laws of thermodynamics, pressure, temperature, absolute scales, heat and its mechanical equivalent, thermal expansion (linear, surface, volume), heat transfer, thermodynamics of steam (sensible, latent heat), steam tables (interpolation).</i> 2- <i>Basic chemical and physical properties of matter.</i>



Syllabus Section#	Outcomes	Objectives
D.	Mechanical Drawing, Administration	
	<i>Sketches, mechanical drawings views, drawing instruments, writing fundamentals sentence, paragraph, and memo composition</i>	1- <i>Setup sketches by centre lines, standard views of objects, drawing instruments, drawing parallel lines, circles, ellipses, cross hatching. Revise poorly worded sentences; punctuate sentences, rules for effective paragraphs.</i>
E.	The Safety Code Act	
	i. <i>Safety Code Act, Occupational Health & Safety Act, and applicable regulations.</i>	1- <i>Through knowledge of the Alberta Safety Act / Boilers and Pressure Vessels Act, Occupational Health & Safety Act, and applicable regulations.</i>
	ii. <i>Codes</i>	
	<i>A.S.M.E Section I: Power boilers</i>	1- <i>Paragraphs PG-67 to PG-73.5 : Safety valves: Design, selection, capacity, testing, adjustment, sealing, blowdown, popping pressure, discharge piping, for superheater and reheater.</i> 2- <i>Water column testing and gaugeglass testing during operation.</i>
	<i>A.S.M.E Section IV: Heating boilers</i>	1- <i>Mounting rules of safety valves on heating boilers, testing, repair.</i> 2- <i>Paragraph HG-605: Low water fuel cutoff of boilers.</i>
	<i>A.S.M.E Section VI: Recommended rules for care and operation of heating boilers.</i>	1- <i>Article 3.27: High limit temperature control.</i> 2- <i>Exhibit C: Procedure for testing flame safeguard devices.</i>
	<i>A.S.M.E Section VII: Recommended rules for care of power boilers.</i>	1- <i>Subsection C4.100 to C4.130: Safety valves: Testing, operation, maintenance.</i> 2- <i>Subsection C2.426: Blowdown of boilers. Boiler inspection rules.</i>



Syllabus Section#		Outcomes	Objectives
		<i>C.S.A. Standard B-51: Construction and inspection of boilers and pressure vessels.</i>	1- <i>On power piping: Blowdown of boilers (piping material, pressure rating, required sizes, valve types for blowdown.</i> 2- <i>Opening for air to boiler room.</i> 3- <i>Blow-off tank for boilers.</i> 4- <i>Low water fuel cutoff for boilers.</i>
		<i>C.S.A. Standard B-52: Mechanical refrigeration code.</i>	1- <i>High pressure safety cut off.</i> 2- <i>Pressure gauge range.</i> 3- <i>Fittings and parts conform to ANSI Standards B31.5.</i> 4- <i>Pressure relief devices.</i> 5- <i>System leak testing.</i> 6- <i>Rules for Installation, inspection, operation, maintenance of refrigeration systems.</i>
F.		Workplace Hazardous Materials	
		WHMIS	1- <i>Classification system for controlled products.</i> 2- <i>List six classes, their subdivisions and exempted materials.</i> 3- <i>Labelling of controlled products. MSDS.</i>
G.		Plant Safety	
	i.	<i>Costs and effects of workplace injuries</i>	1- <i>Financial and legal implications, impact on the injured person, steps to minimize the effect of workplace injuries.</i>
	ii.	<i>Personal protective equipment</i>	1- <i>Basic types of PPE, safety belts and harnesses, respiratory protection types.</i>
	iii.	<i>Isolation of mechanical and electrical equipment</i>	1- <i>Procedures for mechanical and electrical isolation of equipment, safe isolation of a pump driver, a steam boiler, and a sodium Zeolite softener.</i>



Syllabus Section#		Outcomes	Objectives
	iv.	<i>Confined space entry</i>	1- <i>Define a confined space, its hazards, procedures in reference to the provincial regulations, its check list before an entry.</i>
	v.	<i>Handling of gases and hydrocarbon fluids</i>	1- <i>Define gas cylinder markings, safe procedure for handling and changing gas cylinders, the cylinders safety features and its inspection.</i> 2- <i>Properties of common hydrocarbon fluids and source of ignition for them, safety requirements for their loading, transportation, storage, and their gauging.</i>
	vi.	<i>Hydrogen sulphide safety</i>	1- <i>Physical and chemical characteristics of H₂S, the effect on humans in different concentrations, how to respond to H₂S emergency.</i>
	vii.	<i>First aid, CPR and artificial respiration</i>	1- <i>Steps to assess a medical emergency, ABC's of first aid, procedures for heat attack and stroke, the standard emergency assistance procedure.</i>
	viii.	<i>Safety committees</i>	1- <i>Its members makeup, purpose, responsibilities, its regular monthly meeting.</i>
H.		Plant Fire Protection	
	i.	<i>Fire fundamentals and procedures</i>	1- <i>Theory and terminology of fires, fire triangle, 4 classes of fire, components and operation of a typical fire detection and alarm system in an industrial setting.</i> 2- <i>Life safety in fire.</i>
	ii.	<i>Fires and extinguishing methods</i>	1- <i>Fire extinguishing agents and their applications.</i> 2- <i>Main components and operation of the fixed standpipe.</i>
	iii.	<i>Portable fire extinguishers; construction and operation</i>	1- <i>Applicability, construction, operation of various types of portable fire extinguishers, inspection and maintenance of them.</i>



Syllabus Section#		Outcomes	Objectives
	iv.	<i>Electrical fires</i>	1- <i>Causes and preventative measures, hazardous location classifications, divisions, groups, suitable fire extinguishers</i>
I.		Environment	
	i.	<i>Environmental terms and definitions</i>	1- <i>Interdependency between the various elements of the environment, various cycles that make up our environment, ecosystem.</i>
	ii.	<i>Gas and noise pollution</i>	1- <i>Nature, environmental impacts, and control methods for gaseous and noise pollutants in power plants.</i> 2- <i>Adverse effects of CO, SO₂, NO_x.</i> 3- <i>Measurement and control of noise pollutants.</i> 4- <i>Typical devices and systems for monitoring gaseous and noise pollutants.</i>
	iii.	<i>Solid and liquid pollution</i>	1- <i>Nature, environmental impacts, and control methods for solid and liquid pollutants in power plants.</i> 2- <i>Construction and operation of mechanical precipitators, electrostatic precipitators, fly ash removal, and control of liquid thermal pollution.</i>
	iv.	<i>Potential environmental impact of liquids</i>	1- <i>Common source and effects of liquid waste and thermal pollution.</i> 2- <i>Impact of liquid waste on the environment and its preventative measures.</i> 3- <i>The current and alternate methods of liquid waste disposal.</i>



Syllabus Section#		Outcomes	Objectives
	v.	<i>Potential environmental impact of vapours</i>	<ol style="list-style-type: none"> 1- <i>Impact of gases and vapours on the environment.</i> 2- <i>List the common domestic, industrial, and naturally occurring gases and vapours that have environmental impact.</i> 3- <i>The current methods of gas and vapour conditions and disposal</i> 4- <i>The alternative methods of reducing gas and vapour pollution.</i>
	vi.	<i>Potential environmental impact of operating facilities</i>	<ol style="list-style-type: none"> 1- <i>Types of impacts that operating facilities can have on the environment, and how the personnel are alerted to those problems.</i> 2- <i>Noise pollution of facilities. Importance of personnel attitude in limiting the pollutions.</i> 3- <i>Plan for long-term hazardous waste treatment strategies.</i> 4- <i>Environmental cleanup for abandonment of operating facilities.</i>
J.		Material and Welding	
	i.	<i>Engineering material, selection, properties</i>	<ol style="list-style-type: none"> 1- <i>Mechanical properties of ferrous and non ferrous materials used in power plants.</i> 2- <i>The related different alloys.</i>
	ii.	<i>Heat treatment and case hardening</i>	<ol style="list-style-type: none"> 1- <i>Materials used for case hardening.</i> 2- <i>Heat treatment of steel for improvement of its mechanical properties.</i>
	iii.	<i>Fabrication and welding methods</i>	<ol style="list-style-type: none"> 1- <i>Forge welding, oxyacetylene welding, cutting, metal arc welding, and braze welding.</i>
	iv.	<i>Welding processes and electrode use and selection</i>	<ol style="list-style-type: none"> 1- <i>Straight and reverse polarity arc welding, heat treatment of the welding, identification numbers for welding rods, submerged arc welding process.</i> 2- <i>Welding procedure qualification. Preheating and post heating.</i>



Syllabus Section#		Outcomes	Objectives
	v.	<i>Welding terms and inspection</i>	1- <i>Define common terms used in welding.</i> 2- <i>Weld faults, weld inspection and methods of weld testing.</i>
	vi.	<i>Welder qualifications</i>	1- <i>Welder to be ticketed and qualified for the pressure welding.</i>
K.		Piping and Valves	
	i.	<i>Materials; sizes and identification</i>	1- <i>Correct material for the piping. Commercial pipe sizes.</i> 2- <i>The identification markings on the fittings.</i>
	ii.	<i>Piping, pipe fittings and connections</i>	1- <i>Pipe fittings and their identifications, piping tools, piping connection methods.</i> 2- <i>Service symbol for pipe fittings.</i>
	iii.	<i>Expansion joints, bends, support, hangers and insulation</i>	1- <i>Types of expansion joints, bends, piping support, hangers.</i>
	iv.	<i>Drainage; separators, traps, water hammer</i>	1- <i>Steam separator, steam trap types (mechanical, thermostatic, thermodynamic).</i> 2- <i>Trap installation, inspection, water hammer.</i> 3- <i>Piping insulation and its materials.</i>
	v.	<i>Valve types; construction and application</i>	1- <i>Sketch and description of the standard valve designs, special valves for boilers, piping arrangement and operation of steam system pressure reducing valves (PRV).</i> 2- <i>Common materials of construction for valves.</i> 3- <i>Valve identification markings.</i> 4- <i>Valve maintenance.</i>
L.		High Pressure Boiler Design	
	i.	<i>Development of boiler design</i>	1- <i>Boiler developments and general requirements for proper boiler design.</i>
	ii.	<i>Boiler terminology</i>	1- <i>Common terminology used for the boilers.</i>



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	iii.	<i>Firetube boilers; construction, stays, tubes, tube sheets, shell</i>	1- <i>Sketch and description of Horizontal Return Tubular Boiler, Locomotive type boiler, Firebox boiler, Scotch boiler, packaged firetube boiler.</i>
	iv.	<i>Watertube boilers; construction, drums and walls</i>	1- <i>Sketch and description of early water tube boilers, design and construction of packaged watertube boilers, and for large scale steam generating units.</i>
	v.	<i>Electric boilers</i>	1- <i>List advantages and disadvantages of electric boilers compared to fuel fire boilers.</i> 2- <i>Description of construction and operating principles of electrode type, and immersion type electric boilers.</i>
	vi.	<i>Boiler construction; support, suspension, refractory</i>	1- <i>Sketch and description of the general features of watertube and firetube boilers.</i> 2- <i>Design and manufacturing of boiler tube sheets, shells, and drums.</i> 3- <i>The standard types of welded joints used for construction of pressure vessels.</i> 4- <i>General design of the riveted joints.</i> 5- <i>The tools and standard methods used to attaché boiler tubes to tubesheets, headers and drums.</i> 6- <i>Boiler stays, boiler inspection access openings, boiler drum connections.</i> 7- <i>Different types of internal firetube furnace designs.</i> 8- <i>Boiler foundations and supports.</i> 9- <i>Water cooled furnace walls in firetube boilers.</i>
M.		High Pressure Boiler Parts and Fittings	
	i.	<i>Combustion theory, composition of fuel, fuel heating value</i>	1- <i>Composition and combustion of fuels, fuel heating value, combustion and boiler efficiency, heat loss.</i>



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	ii.	<i>Boiler draft equipment; natural, forced, induced, balanced</i>	1- <i>Natural draft and mechanical draft.</i> 2- <i>Draft equipment, stack.</i> 3- <i>Forced, induced, and balanced mechanical draft.</i> 4- <i>Draft control.</i> 5- <i>Methods of furnace pressure measurement.</i>
	iii.	<i>Boiler combustion equipment; coal, oil and gas burners and safety</i>	1- <i>Basic combustion theory for proper conditions.</i> 2- <i>Combustion equations and formula, relationships between theoretical and excess air.</i> 3- <i>Three general classes of boiler fuels.</i> 4- <i>Methods used in the combustion of coals, oil, and gas.</i> 5- <i>Coal mills, pulverized coal burners.</i> 6- <i>Oil atomization burners.</i> 7- <i>Gas burners.</i> 8- <i>Flue gas analysis and its relationship to boiler efficiency.</i> 9- <i>Combustion efficiency.</i>
	iv.	<i>Fluidized bed and grate systems</i>	1- <i>Basic theory and design of a fluidized bed steam generator, and its operation and combustion control.</i> 2- <i>Sketch, description, and operation of a fluidized bed boiler, state.</i> 3- <i>Advantages and disadvantages.</i> 4- <i>Explain two start-up strategies and bed expansion.</i>



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	v.	<i>Safety and relief valves</i>	1- <i>ASME code requirements for safety valves.</i> 2- <i>Construction and operation of high pressure safety valves and safety relief valves, and its discharge piping.</i> 3- <i>Testing and repair of safety valves.</i> 4- <i>Temperature relief device for domestic hot water system.</i>
	vi.	<i>Water columns and gauge glasses</i>	1- <i>Sketch and describe the direct and indirect types of level indicators.</i> 2- <i>Testing water columns and gage glass.</i>
	vii.	<i>Steam drum internals</i>	1- <i>Principles and equipment used to separate steam from water in a steam drum.</i> 2- <i>Sketch a steam drum internals including feedwater pipe, continuous blowdown line, chemical feed line, steam separators, dryers, scrubbers.</i>
	viii.	<i>Superheaters, reheaters, economizers, air heaters</i>	1- <i>Sketch and description of superheaters, reheaters, economizers, and air heaters.</i>
	ix.	<i>Insulation</i>	1- <i>Insulation and desired material characteristics.</i> 2- <i>Piping insulation, boiler insulation.</i>
N.		High Pressure Boiler Operation	
	i.	<i>Boiler prestart, start-up, operation and shutdown</i>	1- <i>Required steps (check list) to prepare a boiler for start-up.</i> 2- <i>A typical boiler start-up procedure.</i> 3- <i>Warm-up procedure for the boiler and steam header.</i> 4- <i>Procedure for shutting down a boiler.</i> 5- <i>Operation routine checks.</i>



Syllabus Section#		Outcomes	Objectives
	ii.	<i>Emergency boiler operation</i>	1- <i>Emergency conditions in boilers and the required responses.</i> 2- <i>Need for boiler operating and maintenance logs, and type of information that should be recorded.</i>
	iii.	<i>Soot blowers</i>	1- <i>Stationary and retractable sootblowers.</i> 2- <i>Shot cleaning method.</i>
	iv.	<i>Continuous and intermittent blowdown</i>	1- <i>The purpose, equipment and operation of continuous and intermittent blowdown.</i> 2- <i>Explain the terms “blowdown” as applies to the process, and “blow-off” as applies to the equipment.</i> 3- <i>Blow-off piping, valves, and tank.</i>
	v.	<i>Chemical and mechanical cleaning, boil out and lay-up</i>	1- <i>Boiler lay-up after shutdown for a period of time.</i> 2- <i>Fire side boiler dry-out, water side boiling out before the start-up.</i>
	vi.	<i>Hydrostatic testing, inspection, safety precaution</i>	1- <i>Boiler inspection, hydrostatic testing procedures, safety precaution.</i>
	vii.	<i>Cause and prevention of boiler furnace explosions</i>	1- <i>Main types and causes of boiler explosions.</i> 2- <i>The safety measures to prevent boiler explosion at fire side and water side.</i>



Syllabus Section#		Outcomes	Objectives
O.		Feedwater Treatment	
	i.	<i>External feedwater treatment, filtration, lime soda, zeolite, deaeration</i>	1- <i>Principles, methods and equipment used in preparing raw feedwater for boiler.</i> 2- <i>Common impurities in raw feedwater and its potential negative effect on a boiler.</i> 3- <i>Water filtering.</i> 4- <i>Purpose, processes, and equipment used in different water softening procedures.</i> 5- <i>Causes of Zeolite softener malfunctions.</i> 6- <i>Theory, process and equipment used in deaeration.</i>
	ii.	<i>Internal feedwater treatment and testing</i>	1- <i>Problems associated with internal boiler water contamination.</i> 2- <i>Internal boiler feedwater chemical feed systems.</i> 3- <i>Standard boiler water tests and what they measure.</i>
	iii.	<i>Knowledge and control of: pH, sludge, scale, foaming, caustic embrittlement, blowdown and corrosion</i>	1- <i>Describe the topic list.</i>



Part “B”

Syllabus Section#	Outcomes	Objectives
Part “B”		
A.	Prime Movers and Engines	
i.	<i>Heat engines, prime mover terminology</i>	1- <i>Conversion of heat into mechanical work.</i> 2- <i>Define “heat engine” and “prime mover” and the difference between them.</i>
ii.	<i>Simple steam engine; construction, details, operation and maintenance, lubrication.</i>	1- <i>Construction, operation, maintenance, and lubrication of a simple steam engine.</i>
iii.	<i>Steam turbines; construction, impulse, reaction, governing, overspeed trip, lubrication, start-up, operation, shut-down</i>	1- <i>Operation principle of impulse and reaction steam turbine.</i> 2- <i>Main components of a simple type of multistage steam turbine.</i> 3- <i>Its sealing and lubrication, rotational speed governing, and overspeed trip.</i> 4- <i>Steps for startup and shutdown.</i>
iv.	<i>Cooling towers, condensers</i>	1- <i>Describe the components, construction, and operation of the natural draft and mechanical draft cooling towers.</i> 2- <i>Factors affecting rate of the cooling towers.</i> 3- <i>Operating cooling towers in cold climate.</i> 4- <i>Trouble shooting guide for cooling towers.</i>



Syllabus Section#		Outcomes	Objectives
	v.	<i>Basic gas turbines; construction, applications, open cycle, regeneration, steam and gas turbine plants</i>	1- <i>Describe the principle of operation, construction, and industrial application of gas turbines.</i> 2- <i>Operational characteristics of gas turbine.</i> 3- <i>Regeneration cycle in gas turbine, and combined steam-gas turbine operating cycles.</i>
	vi.	<i>Internal combustion engines; construction, working cycles, fuels, lubrication, start-up, operation, shutdown</i>	1- <i>Describe application, and operation of internal combustion engines.</i> 2- <i>Fuel types.</i> 3- <i>Describe a basic spark and compression cycle engines.</i> 4- <i>Working cycles for 4 stroke and 2 stroke spark ignition engines.</i> 5- <i>Working cycles for 4 stroke and 2 stroke compression ignition (diesel) engines.</i> 6- <i>Startup, shut down, and maintenance of the internal combustion engines.</i>
B.		Pumps and Compressors	
	i.	<i>Pumps</i>	1- <i>List common applications of pumps in the power plant.</i> 2- <i>Positive and non positive displacement pumps.</i>
	a.	<i>Pumping theory</i>	1- <i>Theory of pumping and the terms associated with it.</i> 2- <i>Define pump performance.</i>



Syllabus Section#		Outcomes	Objectives
	b.	<i>Pump operation and maintenance</i>	1- <i>Construction and function of pump wearing rings.</i> 2- <i>Replacing pump sealing types such as packing, or mechanical seal.</i> 3- <i>Sketch and describe the standard types of mechanical seals.</i> 4- <i>Procedures and equipment for pump bearing and shaft alignment including couplings.</i> 5- <i>Pump startup and priming.</i> 6- <i>Apply pump troubleshooting steps.</i>
	c.	<i>Reciprocating pumps; simplex, duplex, valves, drivers</i>	1- <i>Sketch and describe reciprocating (Positive displacement) pumps, simplex, and duplex types.</i> 2- <i>Its valves and drivers.</i>
	d.	<i>Centrifugal pumps: volute, diffusers, impellers, wear rings, seals, packing, start-up, operation and shut-down</i>	1- <i>Sketch and describe centrifugal pumps, and its parts such as volute, diffusers, impellers, wear rings, seals, packing.</i> 2- <i>Characteristics of centrifugal pumps. Pump cavitations.</i> 3- <i>Startup, operation, and shutdown of centrifugal pumps.</i>
	e.	<i>Turbine pumps, rotary pump</i>	1- <i>Sketch and describe turbine (regenerative) pumps, rotary pumps such as gear type, lobe type, and sliding vane pump.</i>
	ii.	<i>Air Compression</i>	1- <i>Operation principles of the different classifications of air compressors such as reciprocating, rotary, dynamic types compressors.</i>
	a.	<i>Theory, altitude, barometers</i>	1- <i>Theory of air compression, effect of atmospheric pressure, pressure gages, barometers.</i>



Syllabus Section#		Outcomes	Objectives
	b.	<i>Reciprocating compressors; construction, stages, cooling components, valves, control, lubrication and operation</i>	1- <i>Sketch and describe air compressor construction, stages, cooling components, valves, control system, lubrication, and operation.</i>
	c.	<i>Axial; construction, components, lubrication and operation</i>	1- <i>Sketch and describe axial flow (dynamic) compressor including its components, and operation.</i>
	d.	<i>Systems; receivers, intercoolers, aftercoolers, driers, moisture, safety devices</i>	1- <i>Sketch and describe receivers, intercoolers, after-coolers, driers, moisture, safety devices for compressor systems.</i> 2- <i>Describe auxiliary equipment, including capacity control systems for compressors.</i>
C.		Lubrication	
	i.	<i>Lubrication; principles, lubricants, classes, viscosities, applications, systems</i>	1- <i>Importance and principles of lubrication.</i> 2- <i>List different classes and types of lubricants and describe their respective properties and application.</i> 3- <i>List the properties the additives used for lubricating oils, and their selection criteria.</i> 4- <i>Describe lubricating oil properties.</i>
	ii.	<i>Bearing lubrication; operation, maintenance, failure</i>	1- <i>Define boundary and full fluid film lubrication.</i> 2- <i>Sketch and describe shell (sleeve) bearings, and thrust bearings.</i> 3- <i>Describe how to clean and replace roller and ball type bearings.</i> 4- <i>List the causes of bearing failure.</i>



Syllabus Section#	Outcomes	Objectives
D.	Electricity	
i.	<i>Electrical; terms, properties, measurement and calculations</i>	1- <i>Atomic structure of matter and its relationship to electricity.</i> 2- <i>Ohm's law and its application to single resistor circuits.</i> 3- <i>Apply Ohm's law to series and parallel circuits.</i> 4- <i>The factors affecting the resistance.</i>
ii.	<i>Power and work</i>	1- <i>Calculate the power developed in an electric circuit.</i>
iii.	<i>Magnetism and electromagnetism</i>	1- <i>Describe magnetism and the relationship between magnetism and electricity.</i> 2- <i>Right hand rule to determine magnetic field direction in a conductor.</i> 3- <i>Describe the relationship between the magnetism and electricity in an electrical generator and electric motor.</i> 4- <i>Fleming's right hand rule for generators and Fleming's left hand rule for motors.</i>
iv.	<i>Electrical metering devices; voltmeters, wattmeters</i>	1- <i>How voltage, current, and resistance are measured in an electric circuit.</i> 2- <i>Describe the construction and operation of a Kilowatt Hour meter and how to read it.</i>
v.	<i>Conductors, insulators</i>	1- <i>Divisions of materials as conductors and insulators with respect to electricity.</i>



Syllabus Section#	Outcomes	Objectives
vi.	<i>Motors and generators; AC and DC, operation</i>	<ol style="list-style-type: none">1- <i>For single phase and three phases describe the construction and operation of DC generators and motors.</i>2- <i>For single phase and three phases describe the construction and operation of AC generators (alternators) and motors.</i>3- <i>Paralleling alternators and disconnecting them from the line. Interpret the information on a motor nameplate.</i>4- <i>Calculations relating to power factor and power factor correction.</i>
vii.	<i>Transformers</i>	<ol style="list-style-type: none">1- <i>Describe the principle of operation of transformers.</i>2- <i>Describe the construction, operation, and basic calculation of single phase and three phase transformers.</i>3- <i>Describe transformer maintenance and cooling.</i>
viii.	<i>Electrical distribution circuits, breakers, switches, fuses</i>	<ol style="list-style-type: none">1- <i>Describe the standard types of electrical voltage systems.</i>2- <i>Interpret electrical symbols as used in building systems.</i>3- <i>Describe the major components of an electrical distribution system.</i>4- <i>Describe the function and operation of alternate power supply system equipment.</i>
ix.	<i>Safe operation</i>	<ol style="list-style-type: none">1- <i>Describe the safe operation of the electrical systems.</i>



Syllabus Section#	Outcomes	Objectives
E.	Controls, Instrumentation and Computers	
i.	<i>Instrumentation terms and definitions</i>	1- Describe the concept and basic components of a control loop. 2- The various means by which control signals are transmitted. 3- The function of transducers. 4- The types of instrumentation which are not necessarily part of a control loop.
ii.	<i>Methods of process measurement</i>	1- Sketch and describe the standard types of devices used for measuring pressure, level, temperature, flow, and composition such as a gaseous mixture.
iii.	<i>Basic control loop components</i>	1- Describe the principle, construction and operation of transmitters, recorders, and control valves.
iv.	<i>Basic boiler instrumentation and control systems, gauges</i>	1- Describe the purpose, construction and operation of boiler interlocks, safety devices, water level controller, and boiler combustion control systems.
v.	<i>Low water fuel cut-offs, mercury switch, thermocouples</i>	1- Describe the construction and operation of boiler low water level fuel cutoff equipment. 2- List the ASME and CSA code regarding low water fuel cutoffs. 3- Describe the testing and maintenance of boiler low water level fuel cutoffs such as mercury switch and thermocouple. 4- Testing and maintenance of low water fuel cutoff devices.



Syllabus Section#		Outcomes	Objectives
	vi.	<i>Boiler programming controls</i>	1- <i>Describe the operation of equipment that is used to automatically startup and shut down boilers.</i> 2- <i>Interpret operating sequence bar graphs and provide a typical sequence of startup and shut down events.</i> 3- <i>Apply a boiler startup and shut down programmer troubleshooting guide.</i>
	vii.	<i>Types of computers; principles, software programs, languages, applications, components</i>	1- <i>Define the types of computer systems, components, and peripherals used in process control.</i> 2- <i>Mainframes systems, minicomputers, microcomputers, networking.</i>
	vii.	<i>Introductory process computer concepts</i>	1- <i>Describe basic computer working principles.</i>
	ix.	<i>Input and output devices, data recording and storage</i>	1- <i>Describe the application of computers to process control. Inventory and plant management.</i>
F.		Heating Boilers	
	i.	<i>Watertube and tubular heating boilers</i>	1- <i>Describe the construction of watertube and copper tubular heating boilers.</i>
	ii.	<i>Cast iron sectional and modular heating boilers</i>	1- <i>Describe the general construction of cast iron sectional heating boilers.</i> 2- <i>List the advantages of cast iron sectional boilers over watertube and firetube boilers.</i> 3- <i>Describe the arrangement of equipment in a multiple, cast iron sectional boiler heating plant.</i> 4- <i>Describe the construction and operation of cast iron modular heating boilers.</i>
	iii.	<i>Firetube heating boilers</i>	1- <i>Describe the construction and operation of horizontal and vertical firetube boilers used in heating plant service.</i>



Syllabus Section#	Outcomes	Objectives
iv.	<i>Oil and gas burners for heating boilers</i>	<ol style="list-style-type: none"> 1- <i>Sketch and describe air, steam and mechanical oil atomizing burners for boilers.</i> 2- <i>List and describe the auxiliary equipment needed for an oil combustion system.</i> 3- <i>Describe the design and operation of fuel oil systems.</i> 4- <i>Describe fuel oil storage systems. Sketch and describe the operation of an atmospheric, refractory, ring, and combination and pilot gas burners.</i> 5- <i>Describe the construction and operation of automatic gas valves.</i>
v.	<i>Steam heating boiler fittings, attachments and auxiliaries</i>	<ol style="list-style-type: none"> 1- <i>Describe the code requirements for pressure gauges, and safety valves on low pressure steam boilers.</i> 2- <i>Testing and regulating blow down of the safety valves.</i> 3- <i>Repair of a safety valve.</i> 4- <i>Describe the code requirements for water level gauge glasses and columns.</i> 5- <i>Describe the code requirements for feedwater and blowoff connections on low pressure steam boilers.</i>
vi.	<i>Hot water heating boilers, fittings, attachments</i>	<ol style="list-style-type: none"> 1- <i>Describe the code requirements for pressure gauges, and thermometers on hot water heating boilers.</i> 2- <i>Describe the code requirements for safety relief valves and temperature relief devices on hot water boilers and how those devices are tested.</i> 3- <i>Describe the code requirements for stop valves, drain connections, and expansion tanks.</i> 4- <i>List and discuss the types of non required fittings that are used in hot water heating boiler systems.</i>



Syllabus Section#		Outcomes	Objectives
	vii.	<i>Hot water and steam heating boiler operation and maintenance</i>	1- Describe the general preparation and startup of a hot water heating boiler. 2- Describe the operation of a hot water heating boiler under non-routine and routine conditions, including removal from service. 3- Describe the preparation; start up, routine operation and removal from service of a steam heating boiler.
	viii.	<i>Cleaning, inspection, lay up, safety</i>	1- Describe the heating boiler cleaning after it was shut down. 2- Procedure and the chemicals used for the cleaning. 3- Describe inspection of the heating boiler. 4- Procedure and the chemical used for the layup of the heating boiler. 5- Safety issues for the heating boiler such as water level.
G.		Heating Systems	
	i.	<i>Steam heating auxiliaries; convectors, unit heaters, coils, ventilators, air vents, valves, traps, vacuum pumps</i>	1- Describe the construction and operation of steam heating system devices used to transfer heat from the steam to a heated space. 2- List and describe the auxiliary equipment used in a steam heating system, including air vents, radiator valves and traps, and condensate return equipment.
	ii.	<i>Steam heating systems; operation and maintenance</i>	1- Describe standard types of piping and equipment layout for system heating systems. 2- Describe the general operation and maintenance of steam heating systems. 3- Apply a steam heating system troubleshooting guide.



Syllabus Section#	Outcomes	Objectives
iii.	<i>Hot water heating auxiliaries; pumps, controls, valves, expansion tanks, converters, radiant panels, snow melt</i>	1- <i>Sketch and describe the standard piping and circulation layouts of hot water heating systems.</i> 2- <i>Compare the advantages and disadvantages of hot water and steam heating systems.</i> 3- <i>Describe radiant panel and snow melting hot water systems.</i>
iv.	<i>Hot water heating systems; operation and maintenance</i>	1- <i>Describe the purpose and function of standard hot water heating system accessories.</i> 2- <i>Explain how the location of the water circulating pump and the expansion tank are determined.</i> 3- <i>Describe the cleaning, filling, starting, routine operation, and troubleshooting of hot water heating systems.</i> 4- <i>Apply a hot water heating system troubleshooting guide.</i>
v.	<i>Warm air heating system equipment</i>	1- <i>Compare the advantages and disadvantages of forced and gravity warm air systems.</i> 2- <i>List and describe the common sources of warm air heat.</i> 3- <i>List and describe the operational characteristics of directly fired space heaters.</i>
vi.	<i>Warm air furnace components and maintenance; furnaces, humidifiers, air distribution, trouble shooting</i>	1- <i>Describe the operation of furnace components, including both mechanical and electronic filters.</i> 2- <i>Describe and discuss the relative merits of three types of air distribution and duct systems.</i> 3- <i>Describe the recommended maintenance procedures for warm air heating and ventilating systems.</i> 4- <i>Apply a troubleshooting guide for forced warm air systems and components.</i>



Syllabus Section#		Outcomes	Objectives
	vii.	<i>Ventilation and air filters</i>	1- <i>Explain the difference between natural and mechanical ventilation.</i> 2- <i>Describe the types of contaminants found in the air. Describe the types of air heating devices used in buildings.</i> 3- <i>Describe mechanical and electronic air filters.</i> 4- <i>Describe air washers.</i> 5- <i>Describe air sterilizers equipment including ultraviolet lamp, and activated alumina.</i>
	viii.	<i>Infrared and electric heating</i>	1- <i>Describe the concept and application of infrared heating.</i> 2- <i>Describe the construction and operation of gas fired and electric infrared heaters.</i> 3- <i>List the advantages of electric heating systems compared to other types of heating systems.</i> 4- <i>Describe the different methods of electric heating.</i>
H.		Heating Boilers and Heating System Controls	
	i.	<i>Heating boiler feedwater controls</i>	1- <i>Describe the operation of a feedwater float switch operating a valve and a float switch operating a pump.</i> 2- <i>Describe how condensate is collected and returned to the boiler.</i> 3- <i>Explain the purpose and function of heating boiler feedwater and condensate piping connections leading to the condensate tank.</i>



Syllabus Section#		Outcomes	Objectives
	ii.	<i>Heating boiler operating controls</i>	1- Describe the operation of the on-off control, the modulating control and the high limit control found on low-pressure steam boilers and hot water heating boilers. 2- Explain the operation of the common control switches found on a low-pressure heating boiler. 3- Describe the operation of the safety switches found on the fuel supplies of low-pressure heating boilers. 4- Explain the required testing and maintenance of boiler controls.
	iii.	<i>Heating boiler combustion controls</i>	1- Describe the construction and operation of heating boiler flame failure detectors. 2- Describe the testing of hot water heating boiler, flame failure safety devices.
	iv.	<i>Pneumatic controls for heating systems</i>	1- Describe the layout of pneumatic control system and the construction and operation of pneumatic controllers. 2- Describe the construction of final control elements. 3- Explain the function of pneumatic-electric switches and relays, manual pneumatic selector switches, and 3-way air valves. 4- Describe a typical self-contained pneumatic control system.
	v.	<i>Electric controls for heating systems</i>	1- Describe the basic construction and operation of electrical thermostats, humidity controllers, and pressure controllers. 2- Describe the function and operation of the controlled devices in electrical control systems. 3- Explain the operating sequence of a basic electrical control circuit.



Syllabus Section#		Outcomes	Objectives
	vi.	<i>Electronic controls for heating systems, indoor, outdoor, multi-zone, advantages, disadvantages</i>	1- <i>Sketch and describe a simple electronic control system.</i> 2- <i>Describe the common types of temperature, humidity, and pressure sensors used in HVAC electronic control systems.</i> 3- <i>Describe the types and functions of controllers used in HVAC electronic control systems.</i> 4- <i>Describe the output devices in an HVAC electronic control system.</i>
I.		Auxiliary Building Systems	
	i.	<i>Lighting systems, principles, units, incandescent, fluorescent</i>	1- <i>Describe the common types of lighting equipment and systems.</i> 2- <i>Explain the various methods of lighting control.</i> 3- <i>Describe the general requirements and criteria for emergency lighting in buildings.</i> 4- <i>Discuss the interrelationship between lighting, air conditioning, and energy conservation in buildings.</i>
	ii.	<i>Building water supply systems, operation and maintenance, hot water heaters, controls and protection, trouble shooting</i>	1- <i>Describe the cold and hot water distribution system in a building.</i> 2- <i>Describe the construction and operation of building system hot water heaters.</i> 3- <i>Explain what is meant by “backflow prevention” and describe the common methods used.</i> 4- <i>List and describe the construction and operation of water system protective devices in buildings.</i>



Syllabus Section#		Outcomes	Objectives
	iii.	<i>Sanitary drainage systems, maintenance</i>	1- <i>Describe the overall layout of building drainage systems.</i> 2- <i>Describe storm water drainage system for buildings.</i> 3- <i>List the steps to take in the routine maintenance of building sanitary drainage system devices.</i> 4- <i>Apply a troubleshooting guide for sanitary drainage systems.</i>
	iv.	<i>Snow melt systems</i>	1- <i>Describe snow melting hot water or glycol system for driveways and walkways.</i>
J.		Vapour Compression Refrigeration	
	i.	<i>Safety, CSA B-52</i>	1- <i>Describe that beyond certain size limits, national and local codes requires qualified installation and maintenance workers, authorized inspection, use of approved materials, and having piping and electrical installed according to their codes.</i> 2- <i>Explain CSA B-52 regulates the signs on the refrigeration systems, charging and discharging systems, and the owners responsibilities.</i> 3- <i>Explain CSA B-52 regulates posting of emergency shutdown procedure, the information to call for service, and the information to get a hold of authorities.</i> 4- <i>Describe CSA B-52 regulates the safety control devices and release on the refrigeration systems, and the PEE for the workers.</i>



Syllabus Section#		Outcomes	Objectives
	ii.	<i>Thermodynamics of refrigeration</i>	1- <i>Explain the fundamentals of refrigeration.</i> 2- <i>Describe the cycle of operations in a vapour compression refrigeration system.</i> 3- <i>Explain how operating temperatures and pressures are selected and related for a vapour compression refrigeration system.</i> 4- <i>State how the capacity of a refrigeration system is described and how refrigeration tables are used to calculate system performance.</i>
	iii.	<i>Properties of refrigerants</i>	1- <i>Describe how refrigerants are classified and their thermodynamic properties.</i> 2- <i>Describe the properties of refrigerants relating to miscibility, leakage tendency, odour, moisture reaction, toxicity and flammability.</i>
	iv.	<i>Compression refrigeration systems; components, auxiliaries, relief devices</i>	1- <i>Describe the basic layout of compression refrigeration systems.</i> 2- <i>Distinguish between direct and indirect refrigeration systems.</i> 3- <i>Explain how compression refrigeration system temperatures and pressures are related.</i> 4- <i>Describe the layout of packaged refrigeration systems and the role of a refrigeration economizer.</i>
	v.	<i>Refrigeration compressor components</i>	1- <i>Describe the construction and operation of a reciprocating refrigeration compressor.</i> 2- <i>Describe the construction and operation of a rotary refrigeration compressor, and a centrifugal refrigeration compressor.</i> 3- <i>Describe the construction and operation of seals for refrigeration compressors.</i> 4- <i>Calculate the capacity, efficiency, and compression ratio of a refrigeration compressor.</i>



Syllabus Section#	Outcomes	Objectives
vi.	<i>Heat exchangers for refrigeration systems</i>	1- Describe the designs and construction of a refrigeration system evaporators, and condensers. 2- Discuss refrigeration condenser operation and maintenance.
vii.	<i>Refrigeration metering devices and capacity controls</i>	1- Describe the construction and operation of compression refrigeration cycle expansion valves. 2- Describe the types of evaporator and compressor capacity controls.
viii.	<i>Refrigeration cycle controls</i>	1- Describe the operation of temperature, pressure, and humidity controls for refrigeration systems. 2- Describe the actuators used in refrigeration control systems. 3- List and describe the typical refrigeration system shutdown devices.
ix.	<i>Refrigeration system accessories</i>	1- List and describe the operation of the gauges, separators, strainers, and indicators that are used as accessories in refrigeration systems. 2- Sketch and Describe the emergency discharge setup for the refrigeration systems according to B-52.
x.	<i>Compression refrigeration system pre start-up, start-up, operational checks and procedures, shut down</i>	1- Describe how to perform refrigeration system leak tests. 2- Describe how a refrigeration system is dried and charged prior to start-up. 3- Describe how a refrigeration system is purged of non-condensable gases prior to startup. 4- List the steps for adding oil to a refrigeration compressor when it is in service.



Syllabus Section#		Outcomes	Objectives
	xi.	<i>Compression refrigeration system maintenance, testing, charging, surging, trouble shooting</i>	1- <i>Describe the steps in the startup and shutdown of a compression refrigeration system.</i> 2- <i>List the safety shutdown devices that are specific to centrifugal compressors.</i> 3- <i>Describe the routine operation and associated log sheets for compression refrigeration systems.</i> 4- <i>List and describe the standard preventative maintenance procedures for compression refrigeration systems.</i> 5- <i>Apply a compression refrigeration system troubleshooting guide.</i>
K.		Absorption Refrigeration	
	i.	<i>Absorption refrigeration systems, components, auxiliaries</i>	1- <i>Describe the theory and operation of an ammonia absorption refrigeration system.</i> 2- <i>Describe the theory and operation of a lithium bromide absorption refrigeration system.</i> 3- <i>Compare the advantages and disadvantages of absorption and compression refrigeration systems.</i>
	ii.	<i>Absorption refrigeration system operation and maintenance</i>	1- <i>Explain the operation of absorption refrigeration systems with respect to crystallization equilibrium concentration and dilution.</i> 2- <i>Describe an absorption system heat exchanger bypass and pump motor lubrication and cooling.</i> 3- <i>Describe the purging system for an absorption refrigeration system.</i> 4- <i>List the steps in the startup procedure of an absorption refrigeration system.</i> 5- <i>Describe the routine operation of an absorption refrigeration system.</i> 6- <i>Describe the preventative maintenance that should be performed on an</i>



Syllabus Section#		Outcomes	Objectives
			<p><i>absorption refrigeration system.</i></p> <p>7- <i>Apply an absorption refrigeration system troubleshooting guide.</i></p>
L.		Air Conditioning	
	i.	<i>Psychrometric properties of air</i>	<p>1- <i>Explain the composition of air and define the terms, humidity, relative humidity, and dew point.</i></p> <p>2- <i>Define the terms: wet bulb temperature, dry bulb temperature, wet bulb depression and psychrometer, and state the relationship between these terms and relative humidity.</i></p> <p>3- <i>Define the specific volume and enthalpy of air.</i></p> <p>4- <i>Identify and interpret the psychrometric properties of air on a psychrometric chart.</i></p>
	ii.	<i>Applications of the psychrometric chart and comfort conditions</i>	<p>1- <i>Interpret the psychrometric chart to find values of specific properties.</i></p> <p>2- <i>Apply the psychrometric chart to the heating and cooling of air, and calculate heat added or removed.</i></p> <p>3- <i>Apply the psychrometric chart to the humidification and dehumidification of air and calculate moisture added or removed.</i></p> <p>4- <i>Apply the psychrometric chart to combined heating/cooling and humidification problems.</i></p> <p>5- <i>Discuss what is meant by "comfort condition" with respect to the psychrometric chart.</i></p>



Syllabus Section#	Outcomes	Objectives
iii.	<i>Fans for air distribution systems</i>	1- <i>Discuss the theory of air flow and pressure conversions.</i> 2- <i>Describe the major types of air handling fans, their construction and operation.</i> 3- <i>Interpret fan performance curves.</i> 4- <i>Describe fan motors, drives and belt guards.</i>
iv.	<i>Air conditioning duct systems</i>	1- <i>Explain how air duct systems are classified.</i> 2- <i>Describe air duct materials, system layout, fabrication and installation.</i> 3- <i>Describe air duct leakage.</i> 4- <i>List and describe the types of liners and dampers used in air duct systems.</i> 5- <i>Discuss terminal air distribution devices and the principles of diffusion, induction entrainment, and aspiration.</i>
v.	<i>Coil types</i>	1- <i>Describe the general construction of finned type heat exchanger coils.</i> 2- <i>Describe the detailed construction of water coils, glycol coils, and steam coils.</i>
vi.	<i>Coil operation</i>	1- <i>Describe installation and operational principles of water, glycol, and steam coils.</i> 2- <i>Discuss steam traps, control valves, air venting, and vacuum relief for different types of coils.</i>
vii.	<i>Humidification, dehumidification</i>	1- <i>Describe the general purpose and principles of humidification.</i> 2- <i>Describe residential and commercial types of humidifiers.</i> 3- <i>Describe industrial types of humidifiers.</i>



Syllabus Section#		Outcomes	Objectives
M.		Air Conditioning Systems	
	i.	<i>Unitary and critical air conditioning systems</i>	1- <i>List functional components and categories of air conditioning systems.</i> 2- <i>Describe the operation of air handling units.</i> 3- <i>Describe the general layout and operation of unitary air conditioning systems, and central air conditioning systems.</i>
	ii.	<i>Combined air conditioning systems; components, auxiliaries, operation, maintenance</i>	1- <i>Describe the general layout and operation of combined air conditioning systems.</i> 2- <i>Discuss the alternative arrangements of equipment for air conditioning systems.</i> 3- <i>Discuss the selection criteria for air conditioning systems.</i>
	iii.	<i>Air conditioning heat recovery systems</i>	1- <i>Describe the general principle of air conditioning heat recovery and the operation of the "runaround" systems.</i> 2- <i>Describe the thermal wheel air conditioning heat recovery system.</i> 3- <i>Describe the heat pipe air conditioning heat recovery system.</i> 4- <i>Describe the heat pump system.</i>



Syllabus Section#		Outcomes	Objectives
	iv.	<i>Air conditioning system controls</i>	<ul style="list-style-type: none">1- <i>Describe various damper control strategies for air conditioning systems.</i>2- <i>Describe preheat coil control strategies for air conditioning systems.</i>3- <i>Describe heating coil control strategies for air conditioning systems.</i>4- <i>Describe humidification control strategies for air conditioning systems.</i>5- <i>Describe humidification and cooling control strategies for air conditioning systems.</i>6- <i>Describe volume control with static pressure regulation for air conditioning systems.</i>7- <i>Describe complete air conditioning control systems.</i>
	v.	<i>Heat gains and losses in building, system components, auxiliaries</i>	<ul style="list-style-type: none">1- <i>Define heat transmission terminology and identify conversions or related units.</i>2- <i>Describe the heat gains that occur in a building due to conduction, infiltration, radiation, and ventilation.</i>3- <i>Describe the heat gains that occur in a building due to people, lighting, electric motors, appliances and cooking.</i>4- <i>Describe the heat losses that occur in a building due to conduction, convection, radiation, infiltration, and ventilation.</i>



Syllabus Section#		Outcomes	Objectives
N.		Boiler Maintenance	
	i.	<i>Powerhouse maintenance – hand and power tools</i>	1- <i>List the general safe working practices identified by the Worker’s Compensation Board.</i> 2- <i>Describe the types and proper use of hacksaws, files, chisels, hammers, hand threading tools, and measuring tools.</i> 3- <i>Describe the proper layout of work and the use of layout tools.</i> 4- <i>Describe the types and proper use of portable and fixed grinders, hand drills, drill presses and the care of drill bits.</i>
	ii.	<i>Powerhouse maintenance – ladders, scaffolding and hoisting</i>	1- <i>Describe the requirements of setting up work platforms in general and ladders and scaffolding in particular.</i> 2- <i>Describe the general safety precautions and calculations used when rigging equipment.</i> 3- <i>Describe the general safety precautions used when hoisting equipment.</i>
	iii.	<i>Powerhouse maintenance – ropes, cables, and fasteners</i>	1- <i>Discuss the correct use and limitation of wire cable and rope, including cable attachments and rope knots.</i> 2- <i>List, sketch and describe common types of metal fasteners such as screws, bolts, nuts and washers.</i>



Syllabus Section#	Outcomes	Objectives
iv.	<i>Boiler maintenance, refractory, tubes, stays, safety valves</i>	<ol style="list-style-type: none"> 1- <i>Describe the general servicing and maintenance of packaged firetube and cast-iron sectional boilers.</i> 2- <i>State the procedures to be followed for wet and dry boiler layups.</i> 3- <i>Describe the symptoms of a leaking firetube and the procedure for removing (plugging) a firetube from service.</i> 4- <i>Describe two methods of detecting cracks in firetube ends and tubesheets.</i> 5- <i>Describe the general procedure for the removal and replacement of a defective firetube.</i> 6- <i>Repair of safety valves.</i>
v.	<i>Boiler cleaning, inspection, testing, layup, welder qualification</i>	<ol style="list-style-type: none"> 1- <i>Describe the general servicing and maintenance of packaged firetube and cast-iron sectional boilers.</i> 2- <i>State the procedures to be followed for wet and dry boiler layups.</i> 3- <i>Describe the symptoms of a leaking firetube and the procedure for removing (plugging) a firetube from service.</i> 4- <i>Describe two methods of detecting cracks in firetube ends and tubesheets.</i> 5- <i>Describe the general procedure for the removal and replacement of a defective firetube.</i> 6- <i>List the steps and precautions to be taken to prepare a boiler for inspection.</i> 7- <i>Describe the inspection of a boiler.</i> 8- <i>Describe the methods and tools used for mechanical cleaning of a boiler.</i> 9- <i>Describe the inhibited acid method for chemical cleaning of a boiler.</i>



Syllabus Section#	Outcomes	Objectives
O.	Types of Plants	
i.	<i>Hot oil systems, components, auxiliaries, operation, maintenance</i>	<i>1- Describe the general design and layout of a hot oil system. 2- Describe the specific designs of the components of a hot oil system. 3- Describe the general operation and regular inspection of a hot oil system.</i>
ii.	<i>Gas plant and pulp mill processes, equipment, operation, safety</i>	<i>1- List and describe the major process that occurs in natural gas processing. 2- Describe the main processes used in the manufacturing of pulp and paper.</i>
iii.	<i>Steam related oil, food and sawmill processes</i>	<i>1- Describe the basic types of processes that occur in sawmills. 2- Describe the basic types of processes that occur in food processing. 3- Describe the basic processes used in oil refining and the role of steam in those processes.</i>