4. Faculty of Engineering

Represented by

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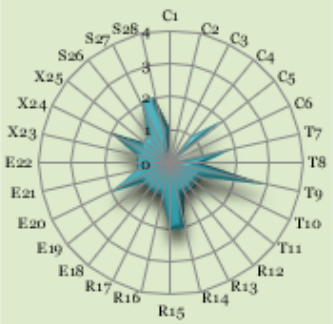
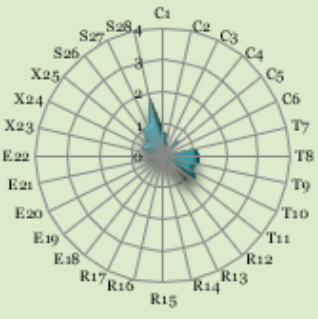
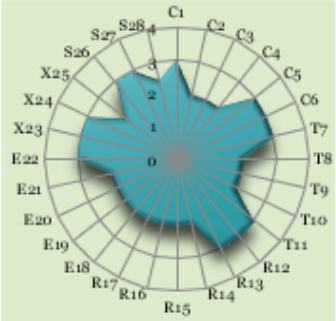
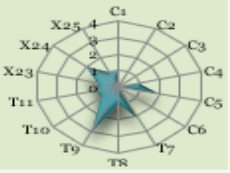
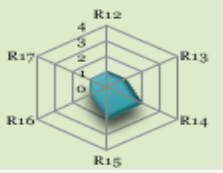
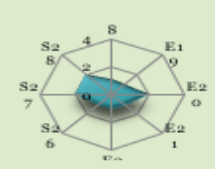
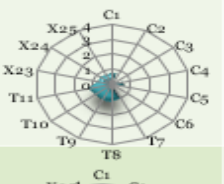
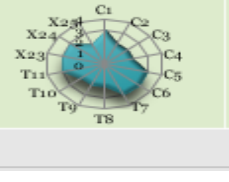
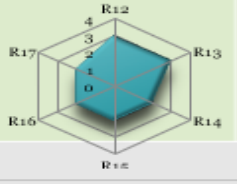
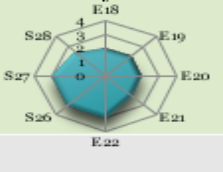
The curricula of the basic sciences, construction and petrochemical engineering programs were reviewed for selection of relevant courses for evaluating the components of sustainable development.

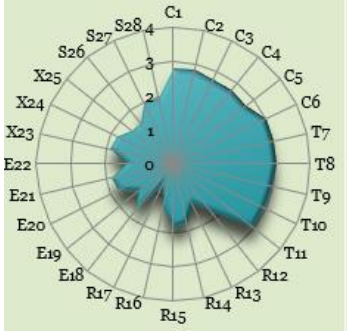
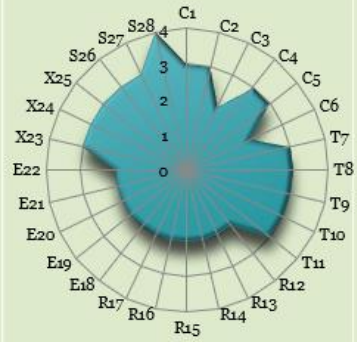
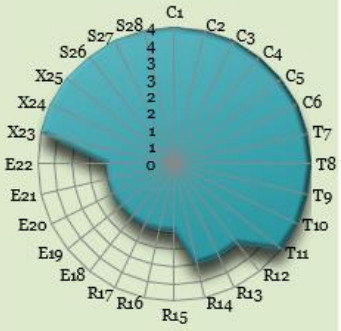
The general evaluation of components of sustainable development in some courses using USAT tool are as follows:

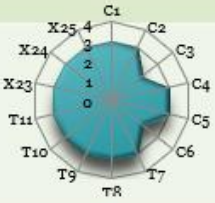
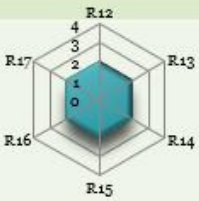
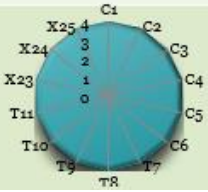
Details

Basic Sciences	Construction	Petrochemical
		

Department	Education	Research	Activities and Practices
Basic Sciences			
Construction			
Petrochemical			

A Proposed plan of action using sustainable development goals as indicators for improvement of the current situation. The results anticipated are:

Basic Sciences	Construction	Petrochemical
		

Departments	Education	Research	Activities and Practices
Basic Sciences			
Construction			
Petrochemical			

Examples of Activities and Practices (year 2018/2019)

Education	Research	Activities
Awareness about sustainability during regular seminars in the department (for staff). Awareness about sustainability during the lectures (for students).	• Opened research areas for water treatment and bio-electromagnetism. (basic sciences dep.) • Opened research areas for effective usage of materials in concrete manufacturing. (construction dep.)	• Workshop about sustainability in cooperation with KTH (for staff). • Workshop about System Thinking and Transdisciplinary to implement sustainability in curriculums (for staff). • Sustainability competition "GO GREEN" • Competition with Birla Carbon company "Towards a sustainable tomorrow"

Infusing sustainability in the curricula- Petrochemical Department

Course code	Course name	Original description	Modifications according to sustainability workshop	Modification according to KTH Recommendations
EP 210	Organic chemistry 1	**This course introduces the students to the principle of organic chemistry including structure, physical and chemical properties of several important functional classes, reaction mechanics and stereo chemical consideration. It also covers relationships between structures, properties and chemical activities. Hydrocarbons, aliphatic and aromatics, structural isomerism, ,compounds containing oxygen, alcohol's, aldehyde, ketone and carboxylic acids, Sulphur compounds nitrogen compounds amines, diazonium compounds petroleum refining and applications, classes of organic compounds encountered in petroleum ,gas and petrochemicals.**	----------	**Topics to be added:** **Chemical structure of polymers and its principles, chain formation.**
EP 214	Inorganic chemistry	**Atomic structure of elements, graduation of elements properties (Modern periodic table), nature of bonds, chemical calculations, hydrogen and its compounds, alkali metals, Group I(A), Group II(A), Group III(A), Group**	----------	----------

		IV(A), Group V(A), Group VII(A), Transition Metals, catalytic properties, & water treatment methods. Introduction to analytical chemistry, quantitative analysis using gravimetric analysis, titration methods, precipitation titration using silver nitrate, acid/base titration (principles and applications), oxidation/reduction titration (argentimetry)& pH measurement		
EP 217	**Material science**	**This course introduces the students to Classification of engineering materials, atomic and molecular structure, bonding and coordination and Properties relationship in materials (metals, ceramic glasses and polymers). It also covers Corrosion resistant materials, composites and their applications, testing of materials and selection factors for various applications. The course focuses on polymer properties and modification for special applications. Crystallography, Solidification of metals and alloys, Phase diagrams (Binary), Iron –Carbon diagram, Heat treatment – Ferrous alloys. The lab concentrates on sample preparation and testing effect of service conditions on the properties of materials, properties of alloys and composites.**	**Topics to be added:** **Suitable materials and alloys applications for sustainability.**	**Topics to be added:** **Physics of polymers, polymer crystal structure , crystalline and amorphous polymers, polymer tensile test, Mechanical properties of polymers (yield fracture, crazing, creep ,etc…).**

EP213	**Organic chemistry II**	**This course introduces the students to a continuation of organic chemistry reaction mechanism and synthesis pathway sulphonations, nitration, oxidations, and polymerization. It also covers the specific classes of compounds derivatives.**	**Topics added:** **Applying the principles of green chemistry to polymer production.**	**Topics to be added:** **Polymerization reactions, molecular weight calculations, radical polymerization of polystyrene, PPO, thermoset polymerization, mechanism, crystallization of polymers.**
EP 314	**Instrumental Analysis**	Measurement and measurement errors , Accuracy and precision , Types of Errors , Statistical analysis , Systems of measurement Units , Intelligent and dumb instrument This course introduces the students to spectroscopic and spectrophotometer analysis, ultraviolet spectrophotometer, molecular fluorescent spectrophotometer, Introduction to chromatographic analysis, Gas and liquid chromatography, sample preparation, Experimental work, and introduction to techniques and instruments used in modern chemical research.	----------	**Topics to be added:** **Ion beam-based methods (SIMS, RBS)** **FTIR- Atomic Absorption** **Photoelectron spectroscopies (XPS, UPS, Auger, etc.)** **Electrical characterization universal testing machine, thermal testing machine ,Rheometers,…etc**
EP 315	**Physical Chemistry**	**This course covers reaction rates, kinetic theory of interfacial gas chemistry, adsorption of gases and liquids. Colloidal Systems, emulsion polymers and fine liquid**	----------	----------

		droplets are covered. Chemical equilibria and effect of temperate and pressure on equilibrium constant		
EP 200	**Chemical engineering thermodynamics 1**	**This course introduces the students to Thermodynamics concepts and definitions, first law of Thermodynamics (Closed and open systems), heat effects, equation of state. It also covers Second law and Carnot Cycle, Rankin cycle and modification, entropy and third law of thermodynamics.**	**Topics to be added:** **Heat effects and its impact on sustainability.**	**Topics to be added:** **Applications of first and second laws of thermodynamics in chemical engineering.**
EP 201	**Introduction to petrochemical industries**	**This course introduces the students to Raw materials for petrochemical industries, Preparation and manufacture of gas and liquid hydrocarbons, Separation methods of paraffin's aromatics and xylenes. It also covers Preparation of methanol, alcohols and ammonia, production of detergents, plastics and synthetic rubber.**	**Topics to be added:** **Alternative sources of feed`s stocks.**	**Topics to be added:** **-Raw materials for petrochemicals (NG, middle distillates).** **-Olefin's production (FCC, Cracking , dehydrogenation technologies…….).**
EP 327	**Chemical Process Principles**	**Fundamentals of material balance calculations, Batch and continuous, steady flow and unsteady process, reactive and non reactive systems for single unit and multi unit process, process with recycle and by-pass with or without purge material balance for Combustion reactions single phase systems, multiphase systems degrees of freedom analysis. Energy balance on closed and open system the steady flow energy**	**Topics to be added:** **Comparison Case studies using Recycle, and by-pass process, with and without using them**	**----------**

		equation tables of thermodynamic data. Energy balance on non reactive process –state properties and hypothetical process paths employed for their estimations , Energy balance for mixing and dissolution process , Energy balance on reactive process , heat of reaction measurements and calculation of heat of reaction , Hess`s law, formation reaction and heat of formation , heat of combustion . Energy balance for combustion reaction, adiabatic reaction temperature.		
EP 389	**Introduction to environmental engineering**	**Clean environmental standards. Rules and regulations applied to soil, water and air. Sources of environmental pollution, estimation of pollutants in the environment and presentation of suitable schemes for abatement and control. The course unit focuses on the application of engineering principles for producing clean environment.**	**<u>Topics to be added:</u>** **Awareness of Community on Sustainability applications ,** **Reuse of waste water and its application**	**<u>Topics to be added:</u>** **Sources of environmental pollution in petrochemical industry, incineration and vent gas treatment, Sustainability applications in petrochemical industries.**
EP 220	**Chemical engineering thermodynamics II**	**Application of The first and second laws of thermodynamics in Chemical Engineering, the heat effects, vapour liquid equilibrium, Thermodynamics of mixtures chemical reaction**	**Topics to be added:** **Application of polymer**	**Topics to be added:** **Phase diagrams of polymer solutions, polymer thermodynamics, entropy**

		equilibrium. Phase rule- solid-liquid equilibrium-solid-gas equilibrium –gas-liquid equilibrium. Vapor –liquid equilibrium: Ideal mixtures. Two compound systems (binary). Three compound systems (ternary) use of modern programs to predict relation ships and diagrams in binary and ternary systems.	**thermodynamics.** **Introduce Exergy and its applications.**	**elasticity, enthalpy elasticity, viscoelasticity.**
EP 231	**heat transfer in chemical process**	Heat conduction, convection and radiation (for steady and unsteady states) and its application in chemical operations, extended surfaces, thermal boundary layer and turbulence. Heat transfer inside pipes and outside geometries, heat transfer in packed beds and chemical reactors, boiling, condensation, Heat exchangers	**Topics to be added:** **Waste heat boilers, Furnaces, Reuse of heat of flue gases, Burner selection (Low NOx burners), recuperators**	**Topics to be added:** **fixed heaters and boilers.**
EP 340	**Safety for petrochemical industries**	proper handling of toxic and dangerous materials, basics of inflammation, fires, and explosions, ways of protection from fires and explosions as well as relevant legislation concerning occupational safety .Hazards peculiar to industries like fertilizer, heavy chemicals petroleum, pulp and paper, tanneries, dyes, paints, pesticides, glass and ceramics, dairy and sugar industries. Guidelines for safeguarding personnel and safeguarding against water	**Topics to be added:** **Safety systems , Flaring systems,** **Case studies**	**Not found in KTH report**

EP 392	**Pollution control in petrochemical industries** **(Elective course)**	**This course introduces the students to introduction, types of pollutants, parameters of water quality (physical, and chemical parameters), Refinery liquid based treatment method, oxidation pond treatment, disposal of sludge, treatment of sludge, treatment of liquid effluents from petrochemical industries, Air pollution control devices, particulate and gaseous states, Removal of ammonia from gases.**	**<u>Topics to be added:</u>** **Incineration**	**----------**
EP 391	**Manufacture of synthetic Rubber**	**Classifications of synthetic rubber, general characteristic of rubber, raw materials for rubber production, butadiene rubber, styrene butadiene rubber, nitrile rubber.**	**<u>Topics to be added:</u>** **Introduce Natural Rubber** **Recycling of Rubber**	**<u>Topics to be added:</u>** **All rubber like materials, EPDM, rubber elasticity, dynamic behavior, damping , thermo plastic elastomers TPU,TPE.**
EP 313	**Mass Transfer (I)**	Molecular mass transfer. Estimation and measurement of diffusion coefficient, analogies among mass, heat and momentum transfer in turbulent flow. Interphase mass transfer, continuous two-phase transport, absorption drying	**<u>Topics to be added:</u>** **Energy saving in dying process (try to reuse heat from other process in heating air,**	**<u>Topics to be added:</u>** **three phase transport.**

			instead of heating) Calculation of the optimum air temperature and humidity in order to reach economic design (Decrease number of drying stages)	
EP 324	**Gas treatment and liquefaction**	Characterization of natural gas systems. Qualitative phase behavior of natural gas systems. Separators design and selection. Mercury removal, water-hydrocarbon system-hydrate formation, inhibition dehydration, sweetening equipment sizing, selection and design. Fundamental of gas liquefaction and liquefaction cycles : houle – Thompson, turbine expansions and external refrigeration . hydrocarbon recovery units, materials equipment performance and selection, natural gas liquefaction plants, LNG storage and degasification plants	**Topics to be added:** **Recovery of valuable products in Gas treatment process, and reuse it in industry.** **Using natural sorbents in gas treatment process** **alternative dry**	**----------**

			treatment technologies	
EP 335	**Polymer (1)**	**Chemistry of polymerization and the polymer manufacturing process. It begins with basic concepts about polymers and polymerization and covers each major type of polymerization with relevant kinetics. The qualitative effect of reactor design on polymer manufacture is discussed as well as actual polymer.** **Basic structure-property relationship and covers many of the modern techniques used in the characterization and testing of polymers in order to determine the structural, thermal, mechanical, and chemical properties of polymers. Topics covered include polymer structure, glass-rubber transition, mechanical properties, viscoelasticity, solution properties and methods of polymer analysis.**	**----------** **----------** **---**	**Topics to be added:** **Compounding and composites.** **lab should include:** **melt flow index,** **SEC/GPC for molecular weight calculations ,** **capillary rheometer [internsic viscosity],** **tensile tester**
EP 333	**Chemical reaction &industrial catalysis**	This course introduces the students to the rate of reaction, interpretation of kinetic data, batch systems, flow systems reaction in series. The reaction rate constant, the reaction order, elementary & non-elementary reaction and molecularity. Reversible reactions, reactor sizing, batch systems, volume change with reactions. Isothermal reactor design, continuous stirred tank reactors (CSTR) and tubular reactors. Pressure drop in reactors. Unsteady state	**Topics to added:** **Regeneration and reused of catalysts.**	**Topics to be added:** **Ziglar Nata,Cr , Metalocene Catalyst , initiators and its applications in petrochemical industries .**

		operation of reactors. Principles of the industrial utilization of heterogeneous catalysis, topics include absorption phenomena, methodology in catalyst preparation, characterization and evaluation of catalysts, diffusion and reaction in porous catalysts, and a survey of major industrial processes. Flow sheeting applications of special Computer programming to design equipment and chemical reactors.		
EP 326	**Gas storage and transportation (Elective course)**	**This course introduces the students to Design theory and methods of production and measurement of natural gas, Transportation, transmission, storage and distribution pipeline network.**	**Topics to be added:** **Properties of reservoir liquid , coefficient of isothermal compression ability of liquid hydrocarbons , pseudo critical properties of HC liquid mixtures(high& low shrinkage crude, wet & dry gases and retrograde compounds).**	**Not found in KTH report**

EP 317	**Unit operations**	**This course introduces the students to Distillation, liquid-liquid extraction and leaching, humidification and crystallization mechanical separation processes (filtration, sedimentation, centrifugation, gas cleaning. Simulate the unit processes by using simulation tools**	**Topics to be added:** **Advanced types of trays &towers.** **In liquid-liquid extraction :Recovery of solvents**	**Topics added:** **Dewatering and electrolysis**
EP 318	**Corrosion engineering**	**This course introduces the students to Importance of corrosion , electro chemical series of metals , Galvanic series of metals , Electrode potential – current density curves Types of Corrosion and mechanisms, corrosion monitoring and detection, metallurgical aspects of corrosion and material selection, and corrosion prevention and control**	**Topics to be added:** **Green corrosion , non-metallic materials degradation**	**Topics to be added:** **polymer degradation and stability.**
EP 320	**Automatic process control**	**This course introduces the students to Theoretical bases of automatic control analysis and design of chemical Process control systems, control aspects of chemical Process, Liner open- loop systems liner closed –loop systems frequency response process application , and computer in Process control.**	----------	----------
EP 328	**Water treatment (Elective course)**	This course introduces the students to Water chemical analysis, water treatment for different uses, Equipment design	**Topics to be added**	----------

		calculations. Water quality overview, water analysis and assay for special purposes, unit operations for water treatment and calculations	**Case study: recovery of valuable salts from industrial waste water. Management of waste water to approach ZLD.**	
EP 329	**Industrial fibers technology**	This course introduces the students to Classification of manmade fibers general view. Of the technological process for the production of manmade fibers regenerated fibers (viscous) synthetic fibers, polyamide, polyester, acrylic and polypropylene fibers.	**Topics to be added:** **The application of synthetic fibers as a partial replacement of natural fibers.**	**Topics to be added:** **bio fibers,(PA 6,10),interphase polymers ,flex fibers, wood fibers.**
EP 336	**polymer science and engineering (2)**	**This course introduces the students to an Introduction to polymer processing, polymer rheology, major types of polymer processing focusing on extrusion, injection, molding, fiber spinning, film blowing, polymer formulation and additives.**	**Topics to be added:** **Recycling of polymers: (Plastic waste to energy)** **Sustainable polymers , polymers from renewable resources**	**Topics to be added:** **biodegradation mechanism, Material selection, reverse engineering, comparison of polymer properties. Adding IR spectroscopy for chemical groups and DSC (crystallinity ,melting point and glass transition temperature),using software (C-mold or mold flow).**
EP 362	**Petroleum refining & evaluation of its products**	**This course introduces the students to Theories of petroleum origin, physical properties with the study of its curves, preparation of crude for refining operations& Chemical**	**Topics to be added:** **Replace petroleum fractions with renewable**	**Topics to be added:** **Refinery catalytic conversion process , hydrotreating, ,dehydrogenation, Aromatization,**

		treatment of petroleum products. Processing of petroleum distillation, atmospheric and vacuumed distillation operation and its calculations, hydrogenation, isomerisation, thermal and catalytic refining, thermal and catalytic cracking, Dewaxing methods. Methods of refining with: alkalis, acids, solvent extraction& the standard specification for petroleum products.	**one (biodiesel)**	**dehydrocylization, alkylation, refinery configurations, integrated LC fining with hydro processing heavy oil residue desulfurization processes, simplified refinery with delayed cockers as primary upgrader, LC fining and delayed cocking ,optimized residue conversion.**
EP 385	**Optimization of chemical process**	This course introduces the students to Theory and methods of optimization, Linear, nonlinear, and dynamic programming, Applications on chemical reactor design, Heat transfer and energy conservation.	---------- ----------	----------
EP 361	**Fertilizers Industries**	**Natural gas as a source for feed stock for fertilizers industries. Gas – shift reaction, ammonia synthesis, urea production, nitric acid and nitrate fertilizers, Formulation of fertilizers for specific needs.**	**Topics to be added:** **Organic-Fertilizers, Bio-Fertilizers,**	**Topics to be added:** **Phosphate and Mg based fertilizers**
EP 368	**Plant Design I**	**Introduction to design, flow sheeting, design information and data. Studies involving application of chemical engineering economic principles to the design of selected chemical manufacturing process. Hazards, industrial safety, site location and plant layout. Detailed design procedure for**	**Topics to be added:** **Material selection.**	**Topics to be added:** **Process flow diagrams in petrochemical industries (PVC,PE,PS,etc..)**

		selected equipment e.g. plat towers for distillation, design of liquid mixing systems, design of gravity settlers, reaction vessels .pumps, and compressors.		
EP 339	**Production of Plastics**	**This course provided an overview on the plastics industry. Comparison will be made to the polymer production industry, non-plastic manufacturing industries .Raw materials for plastics production, thermoplastics, thermoset plastics, methods of plastics production.**	**Biodegradable polymers**	**----------**
EP 390	**Industrial equipment and material handling**	**Introduction to major equipment used in petrochemical industries. Pumps, heat exchangers, distillation columns, pressurized vessels and separators. Conveyors, cranes and packaging.**	**Scrubbers**	**Grinders, pneumatic conveying systems, silos and rotary valves.**
EP 369	**Plant design II**	**Structure of chemical process systems and systematic methods for capital and operating cost calculations. Economic factors in design, economic balances, capital and operating cost estimation techniques, assessment of alternative investments and replacements, and application of compound interest calculations. Simple optimization theory.** **Evaluation of process alternatives. Equipment and materials selection. Factors such**	**Integrated projects for attaining sustainability.**	**Structure of chemical process systems and systematic methods for capital and operating cost calculations in petrochemical industries.**

		as energy, safety, hygiene, and environmental protection		
EP 330	**Energy Conservation** **(Elective course)**	**Different methods of energy conservation: electrical energy conservation, lightening, energy saving, heat energy saving, insulation, reusing of hot waste water, application of solar energy, smart building, equipment design, sensors and computer controlled processes.**	**It is recommended to modified in law 2020.**	**Not found in KTH report**