RANGKA KURSUS
(COURSE OUTLINE)
KURSUS ELEKTIF/ELECTIVE COURSES
SEMESTER II, SIDANG AKADEMIK 2017/2018

Kod dan Tajuk Kursus *(Code and Course Title)*	**EKC 351 KEJURUTERAAN BIOKIMIA** ***(BIOCHEMICAL ENGINEERING)***
Nilai Unit *(Credit Unit)*	3 unit
Komponen Kerja Kursus (%) *(CW Component)*	40%
Komponen Peperiksaan (%) *(EW Component)*	60%
Asas-asas Menilai Kerja Kursus *(CW Assesment)*	Assignment 25%, Test 15%
Prasyarat *(Prerequisite)*	-
Semester Diajar *(Semester Taught)*	Semester II, 2017/2018
Objektif Kursus *(Course Objective)*	This course covers knowledge about principles of biochemical engineering used in industries, design, operation and control of bioreactors used in bioprocess. Various unit operations employed in bioprocess industries, production of chemicals using fermentation and bioprocesses will also be introduced.
Silibus Kursus *(Course Syllabus)*	• Batch and continuous cultures • Aeration and agitation • Kinetics of substrate utilization and product, enzyme kinetics • Bioreactor design • Application of biotransformation processes in industry

Perancangan Mengajar *(Teaching Planning)*	**Tajuk/Kandungan Kursus** *(Topic/Course Contents)*	**Jumlah Kuliah** *(No. of Lecture)*
1. Batch and continuous cultures	- Growth rate, cell growth measurement, cell density and cell growth kinetics. - Semi-batch culture.	5
2. Aeration and agitation	- Oxygen requirement in industrial, fermentation - Determination of oxygen transfer coefficient (k_{La}), mass transfer and microbial respiration - Bubble aeration and mechanical agitation, correlation between oxygen transfer coefficients and operating variables, - Other factors affecting k_{La} values in fermentation vessels.	10

3. Kinetics of substrate utilization and product, enzyme kinetics	- Kinetics of substrate utilization and product formed in cell culture, modelling of cell growth kinetics: (i) ideal model for reactor design (ii) microbial growth kinetics model - Enzyme kinetics and its application in bioreactor design, immobilized enzyme process.	10
4. Bioreactor design	- Bioreactor design, types of bioreactors, continuous stirred-tank reactor, air-lift bioreactor, packed-bed bioreactor, suspended and immobolized cells bioreactors, bubble column reactor. - Scale-up of bioprocess systems.	10
5. Application of biotransformation processes in industry	- Application of biotransformation processes in industry: (i) cell and enzyme as biocatalysts (ii) enzymatic reactions based on cells and isolated enzymes.	7
Ujian Diadakan ***(Test Held)***	**Minggu ke-6 dan minggu ke-11** ***(Week 6 and week 11)***	
Kuiz ***(Jika ada)*** ***Quiz (If any)***	**Boleh diberi pada bila-bila masa** ***(Will be given as surprise or at any time)***	
Rujukan	**Senarai Buku Teks/Rujukan:** **a) Rujukan Utama:** 1) Doran P. M., 'Bioprocess Engineering Principles 2nd Edition, Academic Press, New York, 2012. 2) Shuler, Michael L., and Fikret Kargi. Bioprocess Engineering: Basic Concepts. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2001. **b) Rujukan Tambahan:** 1) Baily J. E. and D. F. Ollis, 'Biochemical Engineering Fundamentals', 2nd Edition, McGraw-Hill, New York, 1986. 2) Nielsen J. and J. Villadsen, 'Bioreaction Engineering Principles', Plenum Press, New York, 2003.	

Kod dan Tajuk Kursus *(Code and Course Title)*	**EKC 352 INTENSIFIKASI PROSES DALAM PROSES-PROSES KIMIA *(PROCESS INTENSIFICATION IN CHEMICAL PROCESSES)***
Nilai Unit *(Credit Unit)*	3 unit
Komponen Kerja Kursus (%) *(CW Component)*	50%
Komponen Peperiksaan (%) *(EW Component)*	50%
Asas-asas Menilai Kerja Kursus *(CW Assesment)*	Assignment 20%, Project Paper 10%, Presentation 10%, Quiz 10%
Prasyarat *(Prerequisite)*	-
Semester Diajar *(Semester Taught)*	Semester II, 2017/2018
Objektif Kursus *(Course Objective)*	The aim of this course is to provide knowledge and understanding of the concept of process intensification in chemical process industry. The students will gain knowledge on the basic operating principles and the application of intensification techniques of a variety of intensified process equipment. In addition, the students are able to describe and discuss the interactions between elements of process system engineering, which are taken into account during process design via their material and energy flows. Hence, exploiting the synergies between the system components leading to processes with better performance plantwide in term of their raw material consumption, energy demand, process economics, environmental impact and sustainability.
Silibus Kursus *(Course Syllabus)*	• Definition of process intensitifation (PI) • PI methodologies. • Techniques for PI application • Basic operating principles • Application of intensified process equipments • Case study

Perancangan Mengajar *(Teaching Planning)*	**Tajuk/Kandungan Kursus** *(Topic/Course Contents)*	**Jumlah Kuliah** *(No. of Lecture)*
1. Definition of process intensitifation (PI)	- Definition of process intensification (PI) and its benefits.	1
2. PI methodologies.	- PI methodologies involved in chemical processes	1
3. Techniques for PI application	- Techniques for PI application: active and passive techniques.	3
4. Basic operating principles	- Basic operating principles of variety of intensifed process equipment.	5

5. Application of intensified process equipments	- Application of intensified process equipments in chemical industries: [i] Reactive Distillation Column: • Operating Principle • Examples of Application [ii] Spinning disc reactor (SDR): • Operating principle and development of models for thin film flow on rotating disc. • Examples of application of SDR to a range of processes [iii] Micro-reactors: • Description and operating principles. • Heat transfer • Mass transfer • Mixing applications [iv] Compact heat exchangers (CHE): • Definition of CHEs • Construction and main properties. • Applications. • Basic design procedures	6 4 4 4 4
6. Case study	- Process intensification in Industrial Practice: How to Design an Intensified Sustainable Chemical Plant	10
Ujian Diadakan ***(Test Held)***	**Minggu ke-6 dan minggu ke-11** ***(Week 6 and week 11)***	
Kuiz *(Jika ada)* ***Quiz (If any)***	**Boleh diberi pada bila-bila masa** ***(Will be given as surprise or at any time)***	
Rujukan	**Senarai Buku Teks/Rujukan:** **c) Rujukan Utama:** 1) Reay, D.A., Ramshaw, C. "Process Intensification: Engineering for Efficiency, Sustainability and Flexibility", 2nd Edition, Elsevier: Butterworth-Heinemann, 2013. 2) Stankiewicz, A. and Moulijn, J. "Re-engineering the chemical processing plant: Process Intensification", Stankiewicz, Andrzej I, Moulijn, Jacob A, *M. Dekker*, 2004. **d) Rujukan Tambahan:** 1) Boodhoo, K., Harvery, A. "Process Intensification for Green Chemistry" Wiley, 2013. 2) Seider, W.D., Seader, J.D. and Lewin, D.R."Product and Process Design Principles: Synthesis, Analysis and Evaluation"' 2nd Edition, Wiley, 2004. Sikdar, S.K. and El- Halwagi, M.M. "Process Design Tools for the Environment", Taylor & Francis. 2001.	

Kod dan Tajuk Kursus *(Code and Course Title)*	**EKC 354 BAHAN-NANO DALAM KEJURUTERAAN KIMIA** ***(NANOMATERIALS IN CHEMICAL ENGINEERING)***
Nilai Unit *(Credit Unit)*	3 unit
Komponen Kerja Kursus (%) *(CW Component)*	40%
Komponen Peperiksaan (%) *(EW Component)*	60%
Asas-asas Menilai Kerja Kursus *(CW Assesment)*	Assignment 15%, Test 15%, Presentation 5%, Quiz 5%
Prasyarat *(Prerequisite)*	-
Semester Diajar *(Semester Taught)*	Semester II, 2017/2018
Objektif Kursus *(Course Objective)*	The aim of this course is to provide basic knowledge on the physicochemical and interfacial phenomena at nanoscale. This understanding will be used to rationalize the construction of nanomaterials, microscale processes and catalysis. Application of nanomaterials for aqueous treatment and biomedical will be discussed in detail. At the end of this course, students will be able to apply the fundamental knowledge of nanomaterials and analyze the complexity of nanosystem.
Silibus Kursus *(Course Syllabus)*	1. The importance of the surface and interfacial phenomena for small particles. 2. Introduction of van der Waals and electrostatic interactions. 3. Self-assembly (Micellization) 4. Nanoparticles for biomedical application 5. Application of nanoparticles as catalyst and nanoabsorbent for aqueous chemical processes 6. Nanohybrid materials for separation processes

Perancangan Mengajar *(Teaching Planning)*	**Tajuk/Kandungan Kursus** *(Topic/Course Contents)*	**Jumlah Kuliah** *(No. Of Lecture)*
1. The importance of the surface and interfacial phenomena for small particles.	- Physical process happened at nanoscale which cannot be rationalized by classical mechanic. - Dimensionless number analysis on nanoscale process. - Concept of stability of nanoparticle systems and some physical characteristics of nanoparticles.	3
2. Introduction of van der Waals and electrostatic interactions.	- Understanding of double layer concept based on Gouy-Chapman theory. - Particles-particles and particles-surface interacting potential calculation.	12

	- Nanoparticles stability and attachment based upon Derjaguin-Landau-Verwey-Overbeek (DLVO) theory. - None DLVO interactions.	
3. Self-assembly (Micellization)	- Critical micelle concentration and the thermodynamic of micellization. - Concept of assembly of nanomaterials to functional materials. - Emulsion, microemulsion and pickering emulsion. - Application of microemulsions	6
4. Nanoparticles for biomedical application	- Using nanoparticles for cell sorting and protein separation. - External force field driven phenomena (either electric field, magnetic field or optical tweezer). - Particles-to-cell interactions on dictating the separation process.	6
5. Application of nanoparticles as catalyst and nanoabsorbent for aqueous chemical processes	- Using zero valent iron/nanotube as nanoagent for water treatment. - Transport and reactivity of nanoparticles in environment. - Relating nanoscale interactions on particle deposition and environmental factors/transformation of nanomaterials. - Using nanoparticles for on-site treatment.	9
6. Nanohybrid materials for separation processes	- Nanoparticles coated macromolecules. - Mixed matrix membrane. - Modular type nanoparticles	6
Ujian Diadakan ***(Test Held)***	**Minggu ke-6 dan minggu ke-11** ***(Week 6 and week 11)***	
Kuiz *(Jika ada)* ***Quiz (If any)***	**Boleh diberi pada bila-bila masa** ***(Will be given as surprise or at any time)***	
Rujukan	**Senarai Buku Teks/Rujukan:** **e) Rujukan Utama:** 1) Jacob N. Israelachvili "Intermolecular and Surface Forces" 3rd Edition, Academic Press (2011). 2) Paul C. Hiemenz and Raj Rajagopalan "Principles of Colloid and Surface Chemistry" 3rd Edition, Marcel Dekker, Inc (1997).	

	f) Rujukan Tambahan: 1) J. Gao, H. Gu, B. Xu, "Multifunctional Magnetic Nanoparticles: Design, Synthesis and Biomedical Applications", Acc. Chem. Res. 2009, 42, 1097 – 1107. 2) M. Ferrari, "Cancer Nanotechnology: Opportunities and Challenges" Nature Review 2005, 5, 161 – 171. 3) M. Elimelech, J. Gregory, X. Jia, R.A. Williams, "Particle Deposition & Aggregation: Measurement, Modelling and Simulation" Butterworth Heinemann (1995). 4) Other journals: Nature Nanotech, ACS Nano, Nano Letter, Nanoscale, Soft Matter, Langmuir. 5) J. Yuan; A. H. E. Müller, "One-Dimensional Organic-Inorganic Hybrid Nanomaterials" Polymer 2010, 51(29), 4015-4036. 6) C. Santhosh; V. Velmurugan; G. Gacob; S. K. Jeong; A. N. Grace; A. Bhatnagar, "Role of Nanomaterials in Water Treatment Applications: A Review" Chem. Eng. J 2016, 306, 1116-1137.

Kod dan Tajuk Kursus *(Code and Course Title)*	**EKC 358 PEMPROSESAN OLEOKIMIA** *(OLEOCHEMICAL PROCESSING)*
Nilai Unit *(Credit Unit)*	3 unit
Komponen Kerja Kursus (%) *(CW Component)*	40%
Komponen Peperiksaan (%) *(EW Component)*	60%
Asas-asas Menilai Kerja Kursus *(CW Assesment)*	Assignment 20%, Test 15%, Quiz 5%
Prasyarat *(Prerequisite)*	-
Semester Diajar *(Semester Taught)*	Semester II, 2017/2018
Objektif Kursus *(Course Objective)*	This course gives an introduction to the oleochemical industry operation. It covers some introduction to oils and fats compositions, vegetable oil/plant mill operations, plant oil refinery process, production of edible products, fatty acid and soap production, as well as biofuel derived from vegetable oil and fats. Various fats and oil analyses will be discussed. Various other oleochemical reactions, process sustainability, environment impact and waste management will be discussed based on specific applications.
Silibus Kursus *(Course Syllabus)*	7. Introduction to oleochemical 8. Fats and oil analysis 9. Vegetable oil 10. Refinery processes 11. Production of edible products 12. Fatty acids and soap production 13. Methyl-ester from vegetable oils and fats 14. Other oleochemical reactions

Perancangan Mengajar *(Teaching Planning)*	**Tajuk/Kandungan Kursus** *(Topic/Course Contents)*	**Jumlah Kuliah** *(No. Of Lecture)*
7. Introduction to oleochemical	- Basics of oils and fats, composition and characteristics, sources and utilization.	3
8. Fats and oil analysis	- Moisture analysis, impurities, composition, appearance, consistency analysis, saponification value, stability analysis etc.	5
9. Vegetable oil	- Extraction, system and processes, unit operations, process equipment, environmental aspects.	6

10. Refinery processes	- Degumming, refining, washing and bleaching, filtration, hydrogenation, winterization, and deodorization.	8
11. Production of edible products	- Liquid oils, plasticized, liquid and powdered shortenings, margarine.	4
12. Fatty acids and soap production	- Applications, manufacturing process, saponification, fat spliting (hydrolysis), acid separation, fractional distillation.	7
13. Methyl-ester from vegetable oils and fats	- Transesterification, esterification, catalysts.	5
14. Other oleochemical reactions	- Eco-friendly and energy efficient processes, environmental impact, waste management, value-added products, challenges.	4
Ujian Diadakan ***(Test Held)***	**Minggu ke-6 dan minggu ke-11** ***(Week 6 and week 11)***	
Kuiz ***(Jika ada)*** ***Quiz (If any)***	**Boleh diberi pada bila-bila masa** ***(Will be given as surprise or at any time)***	
Rujukan	**Senarai Buku Teks/Rujukan:** **g) Rujukan Utama:** 1) O'Brien, R.D. Fats and Oils : Formulating and Processing for Applications. 3rd Edition. CRC Press, Boca Raton, 2009. 2) Lai O.-M., Tan C.-P., Akoh C.C (Editors). Palm Oil: Production, Processing, Characterization and Uses, 1st Edition, Academic Press and AOCS Press, 2012. **h) Rujukan Tambahan:** 1) Gunstone F. D., Hamilton R. J. Oleochemical Manufacture and Applications. Sheffield Academic Press, England, 2001. 2) Hamilton, R. J. Recent Advances in Chemistry and Technology of Fats and Oils. Elsevier Applied Science, 1987. 3) Shahidi, F. Bailey's Industrial Oil and Fat Products. Vol. 1-6, 6th Edition. John Wiley & Sons, New York 2005. 4) Wittcoff, H.A., Reuben, B.G., Plotkin, J.S. Industrial Organic Chemicals, 3rd Edition, John Wiley & Sons, New York, 2012.	

Kod dan Tajuk Kursus *(Code and Course Title)*	**EKC 461 SAINS DAN TEKNOLOGI MEMBRAN** ***(MEMBRANE SCIENCE AND TECHNOLOGY)***
Nilai Unit *(Credit Unit)*	3 unit
Komponen Kerja Kursus (%) *(CW Component)*	40%
Komponen Peperiksaan (%) *(EW Component)*	60%
Asas-asas Menilai Kerja Kursus *(CW Assesment)*	Assignment 15%, Test 15%, Quiz 5%, Presentation 5%
Prasyarat *(Prerequisite)*	-
Semester Diajar *(Semester Taught)*	Semester II, 2017/2018
Objektif Kursus *(Course Objective)*	In this course, the focus will be on the application of membrane processes for (i) desalination (ii) water and wastewater treatment (iii) biomedical and food processing as well as (iv) gas purification. In order to probe the key fundamental concepts and operational principle in depth, the course will focus primarily on five different membrane separation processes, namely (i) microfiltration, (ii) ultrafiltration, (iii) nanofiltration, (iv) reverse osmosis and (v) gas separation would be pursued in detail. Perspective on separation process down to molecular level will be given to familiarize the students with the fundamental forces involved for these membrane processes. Later, a more conventional engineering approaches driven by both empirical calculation and also first-principle mathematical modelling would be used to develop design rule for the membrane processes involved.
Silibus Kursus *(Course Syllabus)*	1. Membranes fabrication, characterization and separation principles 2. Membrane system, fouling and pretreatment 3. Application of membrane technology 4. Mathematical model in membrane technology

Perancangan Mengajar *(Teaching Planning)*	**Tajuk/Kandungan Kursus** *(Topic/Course Contents)*	**Jumlah Kuliah** *(No. Of Lecture)*
1. Membranes fabrication, characterization and separation principles	- Membranes fabrication, characterization and separation principles in microfiltration, ultrafiltration, nanofiltration, reverse osmosis and gas separation.	7
2. Membrane system, fouling and pretreatment	- Membrane system, fouling and pretreatment in desalination, water and wastewater treatment.	14
3. Application of membrane technology	- Membrane technology in biomedical and food industry.	7
4. Mathematical model in membrane technology	- Membrane technology, mathematical models limitation for gas purification in the natural gas industry.	14

Ujian Diadakan ***(Test Held)***	**Minggu ke-6 dan minggu ke-11** ***(Week 6 and week 11)***
Kuiz *(Jika ada)* ***Quiz (If any)***	**Boleh diberi pada bila-bila masa** ***(Will be given as surprise or at any time)***
Rujukan	**Senarai Buku Teks/Rujukan:** **i) Rujukan Utama:** 1) J.D. Seader, E.J. Henley, "Separation Process Principles" 3rd Edition, John Wiley & Sons, New York, 2010. 2) Simon Judd and Bruce Jefferson, Membranes for Industrial Wastewater Recover an Re-use, Elsevier, Kidlington Oxford, 2003. **j) Rujukan Tambahan:** 1) G. Foley, Membrane Filtration: A Problem Solving Approach with MATLAB, Cambridge University Press, New York, 2013. 2) K.-V. Peinemann, S. Pereira Nunes and L. Giorno, Membranes for Food Applications, Volume 3, , Wiley-VCH, Weinheim, 2010. 3) D.R.Paul, Y.P. Yampol'skii, Polymeric Gas Separation Membranes, CRC Press, Boca Raton, 2000.

Kod dan Tajuk Kursus *(Code and Course Title)*	**EKC 464 KEJURUTERAAN BIOPENAPISAN** ***(BIOREFINERY ENGINEERING)***
Nilai Unit *(Credit Unit)*	3 unit
Komponen Kerja Kursus (%) *(CW Component)*	40%
Komponen Peperiksaan (%) *(EW Component)*	60%
Asas-asas Menilai Kerja Kursus *(CW Assesment)*	Assignment 20%, Test 10%, Presentation 5%, Quiz 5%
Prasyarat *(Prerequisite)*	-
Semester Diajar *(Semester Taught)*	Semester II, 2017/2018
Objektif Kursus *(Course Objective)*	The aim of this course is to provide knowledge of different biorefinery concepts and types of biomass resources that serve as feedstock for the production of energy, fuels and chemicals. Students will be provided with an overview on state of the art technology and separation principles used in biorefinery. Students will evaluate using research literature on the process reaction, synthesis and conversion technologies in biorefineries.
Silibus Kursus *(Course Syllabus)*	1. Fundamentals of biorefinery concept 2. Resources, characteristic and energy content of biomass/feedstocks 3. Pretreatment techniques for biomass 4. Process reaction, synthesis and conversion technologies in biorefinery 5. Separation and purification technologies in biorefinery 6. Biorefinery system

Perancangan Mengajar *(Teaching Planning)*	**Tajuk/Kandungan Kursus** *(Topic/Course Contents)*	**Jumlah Kuliah** *(No. Of Lecture)*
1. Fundamentals of biorefinery concept	- Biorefinery principles, type, platforms, product and development - Evaluating biorefinery performances: Performance indicator and Life Cycle Assessment (LCA) - Challenges and opportunities	4
2. Resources, characteristic and energy content of biomass/feedstocks	- Renewable biomass resources and statistics - Chemical composition and energy content of biomass - Bioenergy feedstocks: Starch-based, oilseed-based, lignocellulose-based, and algae-based.	5

3. Pretreatment techniques for biomass	- Thermal, chemical, physicochemical and thermochemical pretreatments - Pretreatment of different types of biomass	6
4. Process reaction, synthesis and conversion technologies in biorefinery	- Thermochemical processing of biomass: General features, fundamental of design calculation & process design - Thermal conversion technologies: Combustion for heat and power, gasification, and pyrolysis. - Chemical production from biomass - Biological conversion technologies: Enzymatic hydrolysis, ethanol & butanol fermentation, syngas fermentation, fundamental of anaerobic digestion, biogas production	9
5. Separation and purification technologies in biorefinery	- Equilibrium-based separation techniques: Distillation, liquid-liquid extraction and supercritical extraction - Affinity-based separation techniques: Adsorption, ion exchange and simulated moving-bed technology for biorefinery applications - Membrane separation - Solid-liquid separation - Hybrid/integrated reaction-separation systems: Process intensification	9
6. Biorefinery system	- Fischer–Tropsch liquid and methanol synthesis - Novel membrane reactors - Algae biorefineries - Value-added chemicals	9
Ujian Diadakan ***(Test Held)***	**Minggu ke-6 dan minggu ke-11** ***(Week 6 and week 11)***	
Kuiz *(Jika ada)* ***Quiz (If any)***	**Boleh diberi pada bila-bila masa** ***(Will be given as surprise or at any time)***	
Rujukan	**Senarai Buku Teks/Rujukan:** **k) Rujukan Utama:** 1) Jhuma Sadhukhan, Kok Siew Ng & Elias Martinez H. "Biorefineries and Chemical Processes: Design, Integration and Sustainability Analysis", Wiley, 2014. 2) Shri Rawaswamy, Hua-Jiang Huang & Bandaru V. Ramarao. "Separation and Purification Technologies in Biorefineries", Wiley, 2013. **l) Rujukan Tambahan:** 1) Yebo Li & Samir Kumar Khanal. "Bioenergy: Principles and Application", Wiley, 2017. **2)** James Clark & Fabien Deswarte. "Introduction to Chemicals from Biomass", Wiley, 2nd. Edition. 2015.	

Nota penting:

Kehadiran pelajar ke kuliah/tutorial/kelas amali adalah **wajib**. Jika tidak hadir tanpa sebab, pelajar boleh dihalang daripada menduduki peperiksaan akhir.