In the name of Allah

Kingdom of Saudi Arabia
KING SAUD UNIVERSITY
College of Engineering
Chemical Engineering Department

CHEMICAL ENGINEERING DEPARTMENT GUIDE

2004
**Chemical Engineering**

Chemical Engineers play a vital role in industrial development and economic prosperity in the Kingdom of Saudi Arabia due to the vast contribution of the chemical and petrochemical industries in the overall Saudi economy. The recent expansions in materials and processed minerals of non-petroleum origin (e.g. phosphates, uranium, iron ...etc.) provide new working grounds for chemical engineers. Other major working areas for chemical engineers is in water desalination (the Kingdom has the largest productivity of desalinated water worldwide), industrial waste treatment, military industries, extractive metallurgy (iron, gold, aluminum), building materials, fertilizers and industrial cleaners. Also, Chemical Engineering encompasses biochemical engineering, which involves the pharmaceutical and food industries and biotechnology. The work of chemical engineers extends from the design and planning of new industrial projects to the operation, control and development of existing industries.

**The department**

The Chemical Engineering Department was established in 1394 H (1974 G) in the College of Engineering at King Saud University. The department has 24 faculty members: 6 Full Professors, 9 Associate Professors, 9 Assistant Professors and 2 Lecturers. Also, there are 9 Teaching and Research Assistants, and 4 Technicians. The department has very well equipped laboratories. Some of these laboratories enable the students to visualize the various chemical processes and how they are interrelated. Besides the student’s laboratories, the department contains faculty laboratories in which they conduct their own research. Also, the department has advanced computation facilities either through direct contact with university and college computers or the departmental personal computers facilities. The departmental computation laboratories are equipped with a number of design, simulation, and control packages that are used by the students to enhance the understanding of the various chemical processes.
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**Bachelor Program**

The B.S. program aims at preparing the students and providing engineers that can satisfy the needs of the industrial and public sectors and also to contribute to the national industrial development in the Kingdom. Therefore, the department is keen to include in its program, besides the basic chemical engineering subjects, courses that cover the most important industries (such as petrochemical industries and water desalination) in the Kingdom. The B.S. program is a five-year program divided into 10 semesters i.e. two semesters per academic year.

The B.S. program requires the student to study a total 160 credit units, of which 15 units are university requirement, 48 units are college requirements and 97 units are required by the department. The department requirement is divided into 66 units as core courses, 17 units as requirement from other disciplines and 14 specialized units which includes: petroleum refining, selected topics in chemical engineering, catalysis and heterogeneous reactors, water treatment and desalination. Finally 5 units are devoted to a design project in which the student designs a complete factory, or simulates an industrial process or conducts a complete laboratory experiment. This design project is intended to polish the students knowledge of chemical engineering. During his course of study, the chemical engineering student studies four laboratory courses in addition to completing a sixty days summer training requirement. During the training program, the students acquire the practical knowledge and the experience for his future employment. Table (1) shows the course requirements in Chemical Engineering.

**Cooperative Program**

The department offers the cooperative program, which combines the formal classroom ’s study and the relevant practical experience. This program aims at bringing the student to distinguished professional standards required of engineers at the industry. It also provides the student with the knowledge of what is to be expected of engineers together with identifying working areas of chemical engineers.
Students admitted to this program are required to complete successfully Level 8 with a GPA of not less than 3/5 and also it is required that the admitted student should not be amongst those who were dismissed of the university on academic grounds. When a student joins this program, he is directed to work 28 weeks in one of the governmental or private sector factories inside or outside the Kingdom. Upon completion of the program, the student will be exempted from 12 specialized credit units required by the department. The student is also exempted of the summer training requirement. Finally, the student is required to write a technical report, which will be discussed in the department and a final grade, will be issued similar to other courses.
### Table (1): Undergraduate Program courses

<table>
<thead>
<tr>
<th>1st Level Course</th>
<th>unit</th>
<th>6th Level Course</th>
<th>unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>102 ENGL English Language -1-</td>
<td>6</td>
<td>324 STAT Engineering Probability and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>105 MATH Differential Calculus</td>
<td>3</td>
<td>249 CHEM Recognition of Organic compounds</td>
<td>2</td>
</tr>
<tr>
<td>103 PHYS General Physics -1-</td>
<td>4</td>
<td>308 CHEM Chemical Eng Thermodynamics -2-</td>
<td>2</td>
</tr>
<tr>
<td>101 IC Introduction to Islamic Culture</td>
<td>2</td>
<td>309 CHEM Unit Operations</td>
<td>3</td>
</tr>
<tr>
<td>101 ARAB Language Skills</td>
<td>2</td>
<td>313 CHEM Heat Transfer Operations</td>
<td>3</td>
</tr>
<tr>
<td>101 IC Introduction to Islamic Culture</td>
<td>2</td>
<td>331 CHEM Fundamentals of Materials science</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2nd Level Course</th>
<th>unit</th>
<th>7th Level Course</th>
<th>unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>203 MATH Differential and Integral calculus</td>
<td>3</td>
<td>104 IC Fundamentals of Political system in Islam</td>
<td>2</td>
</tr>
<tr>
<td>102 GE Workshop</td>
<td>1</td>
<td>316 CHEM Separation Processes -1-</td>
<td>3</td>
</tr>
<tr>
<td>210 GE Engineering Mechanics</td>
<td>3</td>
<td>402 CHEM Chemical Eng Laboratory -1-</td>
<td>2</td>
</tr>
<tr>
<td>204 GE Computer Applications in Eng.</td>
<td>2</td>
<td>323 CHEM Instrumentation and Process Control</td>
<td>3</td>
</tr>
<tr>
<td>102 IC Islam and the construction of Society</td>
<td>2</td>
<td>321 CHEM Computer Aided Chemical Process Design</td>
<td>3</td>
</tr>
<tr>
<td>103 ARAB Expository writing</td>
<td>2</td>
<td>432 CHEM Materials Eng and Corrosion</td>
<td>3</td>
</tr>
<tr>
<td>201 CHE Chemical Eng Principles -1-</td>
<td>3</td>
<td>403 IC Economical System in Islam</td>
<td>2</td>
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<tr>
<td>204 MATH Differential Equations</td>
<td>3</td>
<td>426 CHEM Heterogeneous Reactor Engineering</td>
<td>3</td>
</tr>
<tr>
<td>209 GE Computer programming</td>
<td>3</td>
<td>422 CHEM Selected Topics in Chem Eng -1-</td>
<td>3</td>
</tr>
<tr>
<td>202 CHE Chemical Eng Principles -2-</td>
<td>2</td>
<td>498 CHEM Graduation Project -1-</td>
<td>2</td>
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<tr>
<td>244 CHEM Organic Chemistry -1-</td>
<td>2</td>
<td>411 CHEM Separation Processes -2-</td>
<td>3</td>
</tr>
<tr>
<td>230 CHEM Physical Chemistry Principles</td>
<td>3</td>
<td>421 CHEM Economics of Chemical Processes</td>
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<table>
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<tr>
<th>3rd Level Course</th>
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<tbody>
<tr>
<td>254 MATH Numerical Methods</td>
<td>3</td>
<td>402 GE Administration of Eng Projects</td>
<td>3</td>
</tr>
<tr>
<td>245 CHEM Organic Chemistry -2-</td>
<td>2</td>
<td>405 CHEM Chemical Eng Laboratory -3-</td>
<td>2</td>
</tr>
<tr>
<td>239 CHEM Physical Chemistry Laboratory -1-</td>
<td>1</td>
<td>413 CHEM Desalination and Water Treatment</td>
<td>3</td>
</tr>
<tr>
<td>302 CHEM Computerized Material and Energy Balances</td>
<td>3</td>
<td>441 CHEM Petroleum Refinery Engineering</td>
<td>3</td>
</tr>
<tr>
<td>104 GE Engineering Graphics Principles</td>
<td>3</td>
<td>499 CHEM Graduation Project -2-</td>
<td>3</td>
</tr>
<tr>
<td>312 CHEM Momentum Transport Operations</td>
<td>3</td>
<td>423 CHEM Selected Topics in Chem Eng -2-</td>
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<tr>
<td>307 CHEM Chemical Eng Thermodynamics -1-</td>
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<td>414 CHEM Petroleum Refinery Engineering</td>
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<table>
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<th>9th Level Course</th>
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</thead>
<tbody>
<tr>
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<td>3</td>
<td>402 GE Administration of Eng Projects</td>
<td>3</td>
</tr>
<tr>
<td>245 CHEM Organic Chemistry -2-</td>
<td>2</td>
<td>405 CHEM Chemical Eng Laboratory -3-</td>
<td>2</td>
</tr>
<tr>
<td>239 CHEM Physical Chemistry Laboratory -1-</td>
<td>1</td>
<td>413 CHEM Desalination and Water Treatment</td>
<td>3</td>
</tr>
<tr>
<td>302 CHEM Computerized Material and Energy Balances</td>
<td>3</td>
<td>441 CHEM Petroleum Refinery Engineering</td>
<td>3</td>
</tr>
<tr>
<td>104 GE Engineering Graphics Principles</td>
<td>3</td>
<td>499 CHEM Graduation Project -2-</td>
<td>3</td>
</tr>
<tr>
<td>312 CHEM Momentum Transport Operations</td>
<td>3</td>
<td>423 CHEM Selected Topics in Chem Eng -2-</td>
<td>2</td>
</tr>
<tr>
<td>307 CHEM Chemical Eng Thermodynamics -1-</td>
<td>2</td>
<td>414 CHEM Petroleum Refinery Engineering</td>
<td>3</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>5th Level Course</th>
<th>unit</th>
<th>10th Level Course</th>
<th>unit</th>
</tr>
</thead>
<tbody>
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<td>254 MATH Numerical Methods</td>
<td>3</td>
<td>402 GE Administration of Eng Projects</td>
<td>3</td>
</tr>
<tr>
<td>245 CHEM Organic Chemistry -2-</td>
<td>2</td>
<td>405 CHEM Chemical Eng Laboratory -3-</td>
<td>2</td>
</tr>
<tr>
<td>239 CHEM Physical Chemistry Laboratory -1-</td>
<td>1</td>
<td>413 CHEM Desalination and Water Treatment</td>
<td>3</td>
</tr>
<tr>
<td>302 CHEM Computerized Material and Energy Balances</td>
<td>3</td>
<td>441 CHEM Petroleum Refinery Engineering</td>
<td>3</td>
</tr>
<tr>
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<td>3</td>
<td>499 CHEM Graduation Project -2-</td>
<td>3</td>
</tr>
<tr>
<td>312 CHEM Momentum Transport Operations</td>
<td>3</td>
<td>423 CHEM Selected Topics in Chem Eng -2-</td>
<td>2</td>
</tr>
<tr>
<td>307 CHEM Chemical Eng Thermodynamics -1-</td>
<td>2</td>
<td>414 CHEM Petroleum Refinery Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>
Graduate Program

1. M.S. program

The department offers the degree of Masters of Science in Chemical Engineering since 1401/1402 H (1981/1982 G). 20 students have already obtained their M.S. degrees in the department while 8 students currently enrolled in the program. The M.S. program aims at providing the Kingdom with the qualified national graduates to satisfy the needs of the country. The program has five main specializations (options):

1. Transport phenomena
2. Process Control
3. Chemical Industries
4. Material Engineering
5. Water treatment and desalination

Admission requirements

B.S. students with Chemical engineering major having overall grade of at least “very good” can be admitted to the program. Conditional admission may be granted to students having grades of “good”. In case of admission of students from disciplines other than Chemical Engineering, completion of additional courses may be required from those student.

Course requirements

The study for M.S. degree in Chemical Engineering requires the student to complete 24 credit units from graduate courses listed in Table (2). The student is also required to conduct a scientific research and write a thesis in one of the Chemical Engineering topics. The curriculum is designed as follows: CHE 501 and CHE 511 in the first term, CHE 502 and GE 501 in the second term. Three courses from one of the departmental M.S. options and one course from the general M.S. courses should be taken during the third and fourth terms.
<table>
<thead>
<tr>
<th>Table (2): Master program courses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compulsory M.S. courses</strong></td>
</tr>
<tr>
<td>501 CHE Advanced Thermodynamics</td>
</tr>
<tr>
<td>502 CHE Advanced Reaction Engineering</td>
</tr>
<tr>
<td>511 CHE Transport Phenomena</td>
</tr>
<tr>
<td><strong>Chemical Industries Option</strong></td>
</tr>
<tr>
<td>503 CHE Catalysis in Chemical Reactors</td>
</tr>
<tr>
<td>523 CHE Chemical Plant Management</td>
</tr>
<tr>
<td>524 CHE Waste Treatment</td>
</tr>
<tr>
<td>534 CHE Polymerization Science &amp; Engng</td>
</tr>
<tr>
<td>541 CHE Advances in Petroleum Refining</td>
</tr>
<tr>
<td>551 CHE Selected Topics in Chem. Engng</td>
</tr>
<tr>
<td>505 MATH Numerical Algebra</td>
</tr>
<tr>
<td>506 MATH Ordinary &amp; Partial Diff. Eqns.</td>
</tr>
<tr>
<td><strong>Water Treatment &amp; Desalination</strong></td>
</tr>
<tr>
<td>512 CHE Advanced Heat Transfer</td>
</tr>
<tr>
<td>524 CHE Waste Treatment</td>
</tr>
<tr>
<td>532 CHE Corrosion &amp; its Control</td>
</tr>
<tr>
<td>542 CHE Recent Trends in Desalination</td>
</tr>
<tr>
<td>551 CHE Selected Topics in Chem. Engng</td>
</tr>
<tr>
<td>505 MATH Numerical Algebra</td>
</tr>
<tr>
<td>506 MATH Ordinary &amp; Partial Diff. Eqns.</td>
</tr>
<tr>
<td><strong>Control &amp; System Engineering Option</strong></td>
</tr>
<tr>
<td>521 CHE Adv. Chemical Process Control</td>
</tr>
<tr>
<td><strong>Transport Phenomena Option</strong></td>
</tr>
<tr>
<td>512 CHE Advanced Heat Transfer</td>
</tr>
<tr>
<td>513 CHE Advanced Momentum Transfer</td>
</tr>
<tr>
<td>514 CHE Advanced Mass Transfer</td>
</tr>
<tr>
<td>551 CHE Adv. Topics in Chem. Engng</td>
</tr>
<tr>
<td>505 MATH Numerical Algebra</td>
</tr>
<tr>
<td>506 MATH Ordinary &amp; Partial Diff. Eqns.</td>
</tr>
<tr>
<td><strong>Material Engineering Option</strong></td>
</tr>
<tr>
<td>531 CHE Materials Engineering</td>
</tr>
<tr>
<td>532 CHE Corrosion &amp; its Control</td>
</tr>
<tr>
<td>533 CHE Oxidation at high Temperature</td>
</tr>
<tr>
<td>534 CHE Polymerization Science &amp; Engng</td>
</tr>
<tr>
<td>551 CHE Selected Topics in Chem. Engng</td>
</tr>
<tr>
<td>505 MATH Numerical Algebra</td>
</tr>
<tr>
<td>506 MATH Ordinary &amp; Partial Diff. Eqns.</td>
</tr>
<tr>
<td><strong>MATH</strong></td>
</tr>
<tr>
<td>505 MATH Numerical Algebra</td>
</tr>
<tr>
<td>506 MATH Ordinary &amp; Partial Diff. Eqns.</td>
</tr>
<tr>
<td><strong>EE</strong></td>
</tr>
<tr>
<td>511 EE Modern Control Systems</td>
</tr>
<tr>
<td><strong>ME</strong></td>
</tr>
<tr>
<td>576 ME Advanced Energy Conversions</td>
</tr>
</tbody>
</table>
2. Ph. D. program

The Ph.D. program in Chemical Engineering was approved in 1417 H (1997 G). The program aims at meeting the needs of the Kingdom for qualified individuals with such a highly specialized degree. Graduates are expected to lead in research and development. The program aims also at strengthening the links between the university and the industry through Ph.D. research in specific industrial problems. It also aims at developing and conduct fundamental Chemical Engineering Research. The Ph.D. program has four main specialization (options):

1. Transport phenomena
2. Process Control
3. Chemical Industries
4. Material Engineering

Admission requirements

Students with an M.S. in Chemical Engineering with grades of at least “very good” are admitted to the program. The applicant is also required to score at least 500 in the TOEFL (Test of English as Foreign Language). In case of admission of students with M.S. degree from disciplines other than Chemical Engineering, completion of additional courses may be required from those students.

Course requirements

The study for Ph.D. degree in Chemical Engineering requires the student to complete 18 credit units from graduate courses listed in Table (3) together with successful completion of the comprehensive examination. The student is also required to conduct an original and novel scientific research and write a thesis in one of the Chemical Engineering topics. The student is required to take six compulsory units (CHE 602 and CHE 618) and 12 units chosen from one of the four departmental specializations (options).
Table (3) : Doctorate program courses

**Compulsory Ph.D. Courses**
- 602 CHE Adv. Reaction Engineering (2)
- 618 Unsteady State Transport Phenomena

**Material Engineering Option**
- 604 CHE Advanced Numerical Techniques
- 605 CHE Properties of Gases & Liquids
- 611 CHE Advanced Separation Processes
- 631 CHE Advanced Extractive Metallurgy
- 632 CHE Adv. Physical Metallurgy (1)
- 633 CHE Composite Materials
- 634 CHE Adv. Physical Metallurgy (2)
- 635 CHE Hot Corrosion Engineering
- 636 CHE Corrosion Control
- 637 CHE Advanced in Polymerization
- 638 CHE Selected Topics in Chem. Eng.
- 621 CHEM Structure Analysis
- 631 CHEM Advanced Physical Chemistry

**Control & System Engineering Option**
- 603 CHE Complex Dynamics & Chaos
- 604 CHE Adv. Computational Techniques
- 62 CHE Computer Aided Design for Chem. Industries
- 622 CHE Simulation of Chem. Processes
- 623 CHE Computer Aided Control of Chem. Plants
- 624 CHE Digital Control of Experiments
- 625 CHE Artificial Intelligence in Chemical Industries
- 626 CHE Chemical Processes
- 627 CHE Advanced Control of Processes

**Transport Phenomena Option**
- 601 CHE Statistical Thermodynamics
- 604 CHE Adv. Computational Techniques
- 605 CHE Properties of Gases & Liquids
- 608 CHE Chem. Engng. Experimentation
- 611 CHE Advanced Separation Processes
- 612 CHE Multiphase Flow
- 614 CHE Advanced Heat Transfer (2)
- 615 CHE Combustion Engineering
- 617 CHE Advanced Topics in Diffusion

**Chemical Industries Option**
- 604 CHE Adv. Computational Techniques
- 605 CHE Properties of Gases & Liquids
- 606 CHE Topics in Biomedical Engng
- 607 CHE Adv. Electrochemical Engng
- 611 CHE Advanced Separation Processes
- 613 CHE Biochemical Engineering
- 616 CHE Chem. Engng. Applications in Electronics
- 626 CHE Chemical Processes
- 636 CHE Corrosion Control
- 641 CHE Adv. Petroleum Refining (2)
- 642 CHE Design of Chem. Industrial Systems
- 643 CHE Advances in Polymerization
- 621 CHEM Structure Analysis
- 631 CHEM Advanced Physical Chemistry
Department Laboratories

Student Laboratories

The chemical engineering department has four main undergraduate laboratories where students can practice and integrate all of their knowledge from the undergraduate courses into realistic applications. These laboratories is classified as follows:

1. Unit operation laboratory:
   In this laboratory the students are introduced to and trained on different laboratory-scale chemical processes such as distillation, drying, cooling tower, liquid phase chemical reactors (batch, continuous, tubular) and heat exchanger. The students also learn about many chemical and physical phenomena such as diffusion of liquids and gases, thermal conductivity, solid handling, fluidization and filtration.

2. Petroleum refining laboratory
   In this laboratory, the students are trained on distillation of crude oil and learn how to estimate oil properties such as pour and cloud point, melting point of wax, specific gravity & viscosity of oil and flash & fire point by open cup method. The training also includes water and sediment removal by centrifuge.

3. Material science laboratory
   In this laboratory students learn how to study and analyze the surface and structure of various types of minerals.

4. Process control laboratory
   This laboratory contains several equipment, which are used to introduce the student to process dynamics in open loop and closed-loop modes, instrumentation and control valves. The student also trained on how to tune the conventional PID controller.
Research Laboratories

The chemical engineering department has several research laboratories where Professors carry out their technical research work. These laboratories are:

1. Phosphate manufacturing and processing laboratory
2. Electrochemistry and hydrogen production laboratory
3. Heat transfer and scale & fouling laboratory
4. Catalysis and characterization laboratory
5. Catalytic chemical reaction laboratory
6. Mass transfer enhancement laboratory
7. Advanced Process control application laboratory
8. Hydrodynamics of gas lift reactors laboratory
Research Activities

Separation Processes
- Modeling of facilitated mass transfer across liquid membranes
- Fouling control in reverse osmosis systems
- Use of liquid membranes to separate metal ions
- Use of liquid membranes to separate organic species
- Gas separation by liquid membranes
- Recycling of oil using solvents
- Bio fouling on RO membrane

Material Engineering and Science
- Corrosion and its protection
- Material inspection and testing
- Phosphate ores transportation
- Phosphate ores concentration and processing
- Oxidation and corrosion at high temperature
- Modeling of Iron extraction processes

Process Control and Optimization
- Development and application of advanced control strategies
- Determination of optimum process operating conditions
- Optimal flowsheeting of chemical processes
- Dynamic modeling of chemical processes
- Identification of chemical processes
- Nonlinear PID controller and tuning
- Multivariable control systems

Chemical and Petrochemical Industries
- Synthesis gas manufacturing
- Phosphoric acid production
- Phosphoric fertilizer production
- Hydrocarbon synthesis by oxidative dehydrogenation

Electrochemical Engineering
- Development of suitable electrodes for hydrogen production
- Modeling and simulation of electrochemical systems
• Mass transfer enhancement in electrochemical cells
• Electrochemical corrosion control

**Biochemical Engineering**
• Oxygen transfer enhancement in bioprocesses
• Extraction and isomerization of glucose
• Enzymes reactions and application
• Modeling of activated sludge reactors
• Biotreatment of industrial gaseous wastes

**Fluid Mechanics and Fluidization**
• Hydrodynamics of non-Newtonian two-phase systems
• Fluid flow in porous media and fluidized beds
• Computational Fluid Dynamics
• Rheology of fluids

**Catalysis and Chemical Reaction Engineering**
• Modeling of fixed and fluidized bed reactors
• Chaos and bifurcation analysis
• Preparation and development of catalysis
• Bubble and gas lift reactors
• Kinetics of catalytic chemical reactions

**Transport Phenomena**
• Oxygen transfer enhancement for liquid waste treatment
• Effect of nonreactive, insoluble particles on mass transfer
• Heat transfer enhancement using advanced strategies
• Mass transfer enhancement in fluids
• Fouling of hot surfaces

**Environmental Engineering**
• Water treatment and desalination
• Treatment of industrial waste
• Air pollution control
• Treatment of underground water
• Waste Water treatment and recycle
• Fuel cell technology for clean power production
Selected publications of the department


33. **M. E. E. Abashar**, "Integrated Membrane Reactors with Oxygen Input for Dehydrogenation of Ethylbenzene to Styrene", The 16th Symposium of Malaysian Chemical Engineers (SOMChE 2002), Malaysia.


Also published in the proceedings of the WEC titled ‘Chemical and Environmental Engineering’


**Patent**


**BOOKS**


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