Change is like a shark in the ocean. Change never stops, never sleeps: it must always keep moving. The good news is if you hate the way things are, they will change. The bad news is if you love the way things are, they are certain to change as well. The only thing inevitable about life is change, not death. Change is here to stay!

“The ILLITERATE of the 21st century will not be those who can’t read or write but those who can’t learn, unlearn and relearn” Alvin Toffler
The 3 Domains of Educational Goals

- Cognitive
  The Head

- Psychomotor
  The Hand

- Affective
  The Heart

Active Learning—Just Do it

A quote from Ira Ramsen (1846-1927), who wrote his memories as a child experiencing a chemical phenomenon:

"While reading a textbook of chemistry, I came upon the statement, ‘nitric acid acts upon copper’… and I [was] determined to see what this meant. Having located some nitric acid… I had only to learn what the words ‘act upon’ meant…. In the interest of knowledge I was even willing to sacrifice one of the few copper cents then in my possession. I put one of them on the table; opened the bottle marked ‘nitric acid’ poured some of the liquid on the copper; and prepared to make an observation. But what was this wonderful thing which I beheld? The cent was already changed, and it was not a small change either. A greenish blue liquid foamed and fumed over the cent and the table. The air… became colored dark red…. How could I stop this? I tried by picking up the cent and throwing it out of the window… I learned another fact; nitric acid… acts upon fingers. The pain led to another unpremeditated experiment. I drew my fingers across my trousers and discovered nitric acid acts upon trousers…. I tell it even now with interest. It was revelation to me. Plainly the only way to learn about such remarkable kinds of action is to see the results, to experiment, to work in the laboratory”. (Adopted from Gutman, 1940).
All science graduates must have practical skill and that is a PROMISED

"Give a man a fish, and he will eat for a day. Teach him how to fish, and he will eat for a lifetime." Towards lifelong learning Chinese Proverb

Copyright Dr JJ, ASERG, UiTM, May 2008
Learning Outcomes
At the end of day 1 workshop, participants will be able to:

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Instructional Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. State and describe the role of MQF and MQA in promoting and maintaining quality &amp; standards of higher education in Malaysia.</td>
<td>Lecture-discussion</td>
</tr>
<tr>
<td>2. Define and explain the meaning of outcome and Outcome-Based Education.</td>
<td>Lecture-discussion</td>
</tr>
<tr>
<td>3. State the principles of OBE and discuss the general and special features of OBE.</td>
<td>Lecture-discussion</td>
</tr>
<tr>
<td>4. Visually relate the concepts &amp; terminologies used in OBE.</td>
<td>Independent reading &amp; lecture on concept map</td>
</tr>
<tr>
<td>5. Identify, select and use the appropriate action verbs for the cognitive, psychomotor and affective learning domains.</td>
<td>Lecture-discussion</td>
</tr>
</tbody>
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Learning Outcomes
At the end of day 1 workshop, participants will be able to:

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<tbody>
<tr>
<td>6. Discuss &amp; agree on a set of workable Program Educational Objectives (PEO)</td>
<td>Group discussion</td>
</tr>
<tr>
<td>7. Discuss &amp; agree on a set of workable Program outcomes (PO)</td>
<td>Group discussion</td>
</tr>
<tr>
<td>8. Complete the PO-PEO matrix &amp; the PO-PEO-ALO-MOHE Soft Skills matrix.</td>
<td>Group discussion</td>
</tr>
<tr>
<td>9. Rewrite the existing course outcomes in the present course file and hence the syllabus to suit the principles of OBE.</td>
<td>Group discussion</td>
</tr>
<tr>
<td>10. Complete the CO-PO matrix (syllabus) with the designated learning activities and assessment tools using the new syllabus format.</td>
<td>Group discussion</td>
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</tbody>
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# Learning Outcomes

At the end of day 2 workshop, participants will be able to:

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To promote confidence to the public; stakeholders (any group which has an interest in, involvement with, dependence on, contribution to, or is affected by, our graduates);

that the quality of provision and standards of awards in higher education institutions (HEIs) are being safeguard and enhanced.

Confidence is promoted by :-

- Conducting institutional self-review to evaluate
  - The performance of programme outcomes
  - Quality of learning opportunities
  - The institutional capacity and management of standards and quality

- Ensuring intense scrutiny and transparency of the process of institutional self-review through the use of nationally agreed guidelines on criteria and standards, a qualifications framework and procedures for quality assurance

- Reporting and making available objective and independent information on the reviews.
Quality Assurance involves

The use of evidence
To check that goals are being achieved

The use of evidence
To reshape goals and practices

Bring about improvement
Functions of MQA

- To implement MQF as a reference point for Malaysian Qualifications
- To develop standards and criteria and all other relevant instruments as national references for the conferment of awards with the cooperation of stakeholders
- To assure quality of HEIs and programmes
- To accredit courses that fulfill the set criteria and standards
- To facilitate the recognition and articulation of qualifications
- To maintain the Malaysian Qualification Register (MQR)

MQA Code of Practice

Good Practices:

- Encourages a variety of teaching and learning methods
- Ensures the choice of credible student assessment methods appropriate for the teaching and learning methods chosen;
- Ensures there are adequate resources to deliver the curriculum;
- Is concerned with good outcomes rather than detailed specifications of content
• Point of reference & joint understanding of HE Qualifications in Malaysia
• An instrument that
  • develops and classifies qualifications based on a set of criteria that are approved nationally and benchmarked against international best practices,
  • and which clarifies the earned academic levels, learning outcomes of study areas and credit system based on student academic load (Student Learning Time, SLT).
• These criteria are accepted and used for all qualifications awarded by recognised higher education providers. Hence, MQF integrates with and links all national qualifications.
QUALIFICATION LEVELS & PATHWAYS

- MIN HUMAN RESOURCE
- ADV DIPLOMA
- SKILLS DIPLOMA
- SKILLS CERT
- SCHOOL CERT

POLYTECH & NON DEGREE GRANTING COLLEGES
- ADV DIPLOMA (40C)
- TECH & VOC (90C)
- TECH & VOC CERTIFICATE (60C)

LIFE LONG LEARNING
- POSTGRAD CERT & DIPLOMA
- GRADUATE CERT & DIPLOMA

HIGHER SCHOOL CERT; FOUNDATION MATRICULATION
- UNIVERSITY DOCTORAL
- MASTERS
- B. (HONS) (120C)

LIFE LONG LEARNING
- UNIVERSITY DOCTORAL
- MASTERS
- B. (HONS) (120C)

Malaysian Qualifications Register (MQR)

- Registers all accredited qualifications and programmes.
- The reference point for credit transfer between programmes and qualifications that are accredited.
Institutional Audit Process

1st Stage
- Higher Education Provider conduct Internal Quality Audit
- Submit Self Review Portfolio

2nd Stage
- External evaluation
- On-site visit by independent Panel of Auditors

3rd Stage
- Authoritative Reports & Ratings, on HEP’s achievements of its mission, goals & objectives; strengths; areas of concern / enhancement

Why me??
Me with the Director General of UNESCO

Criteria 6: RESOURCES FOR THE EDUCATIONAL PROGRAMME

Education expertise

i. What policy does the institution have to ensure that its education expertise and methodologies are appropriate for the delivery of the curriculum?

ii. Does institution have access to an expert education unit or other educational expertise and how are they used?
What is OBE??
Aligning the Vision
The Outcomes
The Content
The Learning Activities
The Assessment

Outcome Based Education

An outcome is:
- The result or consequence of a performance (in terms of success and failure).
- The way a thing turns out; a consequence
  - The outcomes of my discussion with Shamsul is...
  - After of pre-diploma at FSG, students must be able to...
  - This workshop will produce....

Copyright DrJJ, ASERG, FSG UiTM, April 2008
Learning Outcomes are **statements that explain what students should know, understand and can do upon the completion of a period of study.**

Learning outcomes are **references for standard and quality** as well as for the **development of curriculum in terms of teaching and learning, determination of credits and the assessment of students.**

Learning outcomes are linked to the credit system which **gives value to all student learning time** and are not based on the contact hours between lecturers and students.

---

**What is a Program/Course/Lesson Outcome??**

*A statement of what students will be able to do when they have completed the program/course/lesson and it involves graduate’s skills and knowledge that arise from the educational activities of the program/course/lesson which lead to the achievement of the Program Objectives*

An outcome has three major components:

- A description of what the students will be able to do
- The conditions under which the students will perform the task.
- The criteria for evaluating students’ performance.
An outcome at the course level

At the end of this activity, you will be able to write at least 5 attributes of your graduates for the program you are developing.

Outcome Based Education

MOHE
Institutional Attributes
Program level (Still general)
Course Level (Specific but not measurable)
Lesson Level (Very specific & MUST be measurable)

General (not measurable)
Very general (not measurable)
Outcome Based Education

**What is OBE?**

OBE is a method of curriculum design and teaching that focuses on what students can actually do after they are taught. OBE addresses the key questions as:

- Why do you want them to learn it? – **Vision, Mission, PEOs, POs**
- What do you want the students to learn? – **course structure, syllabus**
- How can you best help students learn it? – **Learning Activities**
- How will you know what they have learnt? - **Assessment**

Towers (1996) listed four points to the OBE system that are necessary to make it work:

a) What the student **is to learn must be clearly identified**.
b) The student’s progress is based on demonstrated achievement.

**c) Multiple instructional and assessment strategies** need to be available to meet the needs of each student.

d) **Adequate time and assistance need to be provided** so that each student can reach the maximum potential.
OBE’s instructional planning process is a reverse of that associated with traditional educational planning.

The desired outcome is selected first and the curriculum, instructional materials and assessments are created to support the intended outcome (Spady 1988; 1993).

All curriculum and teaching decisions are made based on how best to facilitate the desired final outcome.

OBE goes beyond ‘structured tasks’ (e.g. memorization)

OBE demands that students demonstrate his/her skills through more challenging tasks like writing project proposals and completing the projects, analyzing case studies and giving case presentations etc.

Such exercises require students to practice and demonstrate their ability to think, question, research, make decisions and give presentations.
OBE involves students in a **complete course of learning**, **developing their skills** in designing to completing a whole process (Spady, 1994a, 1995).

OBE also **identifies higher levels of thinking** (e.g. creativity, ability to analyze and synthesize information, ability to plan and organize tasks). Such skills are emphasized especially when students are assigned to organize and work as a community or entrepreneurial service teams to propose solutions to problems and market their solutions.

---

**4 Principles of OBE?**

1. **Clarity of focus about outcomes**
   - Always have the significant, culminating exit outcomes as the focus.
   - Let the students know what they are aiming for.

2. **Designing backwards**
   - Design curriculum backward by using the major outcomes as the focus and linking all planning, teaching and assessment decisions directly to these outcomes.
3. Consistent, high expectations of success
- Set the expectation that OBE is for ALL learners.
- Expect students to succeed by providing them encouragement to engage deeply with the issues they are learning and to achieve the high challenging standard set (Spady, 1994b).

4. Expanded opportunity
- Develop curriculum to give scope to every learner to learn in his/her own pace.
- Cater for individual needs and differences, for example, expansion of available time and resources so that all students succeed in reaching the exit outcomes.
The objective of Malaysian Higher Education system is to produce professionals as demanded by the nation for human resources.

One purpose of higher education is to graduate students who will become productive citizens. Skills employers consistently seek from university graduates:

- Scientific (problem-solving) skills
- Communication skills
- Decision-making skills which enable students to become leaders
- Well-developed analytical skills
- Teamwork skills
- Well-practiced leadership skills.
- Good interpersonal skills
MOHE’s Attributes of Human Capital with First-Class Mentality*. Producing all rounded person & professional

Knowledge Attributes:
• Mastery of core subjects and ability to apply that knowledge
• Mastery of Bahasa Malaysia and English, and at least one other global language.
• A continuing passion for knowledge through lifelong learning.
• Excellent general knowledge and interest in current events.
• Appreciation of the arts, culture and sports.
• Sound analytical and problem-solving skills.
• Awareness of business and management principles, and technology.

Personal Attributes:
• Goal-oriented: proactive, self-starting, self-disciplined, confident, resilient, motivated, and fiercely competitive.
• Intellectually engaging: creative, innovative, and possessing critical thinking skills.
• Quick learner, adaptable, and flexible.
• Entrepreneurial.
• Ethically and morally upright.
• Spiritually grounded.
• Compassionate and caring (through volunteerism and social services).

Interpersonal Attributes:
• Able communicator and effective presenter.
• Able to relate and be comfortable with people at all levels.
• Able to develop and leverage on personal and professional networks to achieve goals.
• Natural leader.
• Team player.

MOHE’s Attributes of Human Capital with First-Class Mentality*. Producing all rounded person & professional

MOHE 8 Learning Outcomes

Academic Learning Domains (ALDs)

1. Knowledge (K)
2. Practical Skills (P)
3. Social skills and responsibility (A)
4. Values, attitudes and professionalism (A)
5. Communication, leadership and team skills (P/A)
6. Problem solving and scientific skills (K/P)
7. Information management and lifelong learning skills(P/A)
8. Managerial and entrepreneurial skills (K/P/A)
7 Soft Skills Learning Outcomes (LO KI)

1. Communication skills (P)
2. Critical thinking and problem solving (P)
3. Lifelong learning and information management (A)
4. Group working skills (A)
5. Entrepreneurship skills (P)
6. Ethics and professionalism (A)
7. Leadership skills (A)
MQF Framework for Diploma level-Outcomes

Diploma level education balances theory and practice or practical, and stresses on the instillation of values, ethics and attitudes to enable students to:

(i) use knowledge, comprehension and practical skills at work;
(ii) assess and decide, taking into account social, scientific and ethical issues with moderate autonomy;
(iii) be confident and entrepreneurial in pursuing their own careers;
(iv) be responsible members of society;
(v) possess study skills in adapting to ideas, processes and new procedures for career development;
(vi) acquire team and interpersonal skills that are appropriate to employment; and
(vii) communicate effectively and to transmit information, ideas, problems and resolutions cogently to experts and non-experts.
MQF – Bachelors degree (Hons.)

A Bachelors degree prepares students for general employment, entry into postgraduate programme and research as well as highly skilled careers. It enables the individuals to pair responsibilities, which require great autonomy in professional decision-making. The bachelors degree is conferred on individuals who are able to:

(i) demonstrate knowledge and comprehension on fundamental principles of a field of study, acquired from advanced textbooks;
(ii) use the knowledge and comprehension through methods that indicate professionalism in employment;
(iii) argue and solve problems in their field of study;
(iv) show techniques and capabilities to search and use data to make decisions having considered social, scientific and relevant ethical issues;
(v) communicate effectively and convey information, ideas, problems and solutions to experts and non-experts;
(vi) apply team and interpersonal skills which are suitable to employment; and
(vii) possess independent study skills to continue further study with a high degree of autonomy.

MQF Framework for Masters level - outcome

A Masters Degree provides for the furtherance of knowledge, skills and abilities obtained at the Bachelors level. The entrance to masters is usually based on proven capabilities to pursue postgraduate studies in the selected fields. A masters degree is conferred on students who are able to:

(i) demonstrate continuing and additional knowledge and comprehension above that of the bachelors degree and have capabilities to develop or use ideas, usually in the context of research;
(ii) use the knowledge and comprehension to solve problems related to the field of study in new situations and multi-disciplinary contexts;
(iii) integrate knowledge and manage complex matters;
(iv) evaluate and make decision in the situations without or with limited information by considering social responsibilities and related ethics;
(v) deliver clearly the conclusion, knowledge and the rationale to experts and non-experts; and
(vi) demonstrate study skills to continuously progress on their own with a high degree of autonomy to do so.
UiTM’s VISION (2006)
To establish UiTM as a premiere university of outstanding scholarship and academic excellence capable of providing leadership to Bumiputera’s dynamic involvement in all professional fields of world-class standards in order to produce globally

UiTM’s PHILOSOPHY (2006)
A believe that every individual has the ability to attain excellence through the transfer of knowledge and the assimilation of moral values so as to become professional graduates capable of developing knowledge, self, society and the nation.
UiTM’s MISSION (2006)
➢ To enhance the knowledge and expertise of Bumiputera’s in all fields of study through professional programmes, research work and community service based on moral values and professional ethics.

FSG’s VISION
➢ To Become The Premier Institution In Science And Technology Through Quality Teaching, Research, And Service.

FSG’s MISSION
➢ Contributing to the country’s growth & sustainability through teaching & learning by:
  ➢ Developing student’s potential via the most effective instructional strategies & producing graduates who are knowledgeable, creative, innovative, competitive, skillful in science & thinking skills and having personal & moral attributes coherent with the social, religious, societal and professional needs.
Programme Educational Objectives :-
I) A competent plantation semi-professional with scientific and management knowledge.
II) A plantation semi-professional with good attitudes and ethics necessary in fulfilling his/her responsibilities towards the Creator, client, society and the environment.
III) A plantation semi-professional who is able to adapt him/herself to the international/global work environment.
IV) A plantation semi-professional who is able to lead a workforce based on experience, knowledge and skills.
V) A plantation semi-professional who is able to assist in conducting research in his/her own organization.
VI) A plantation semi-professional who is aware of relevant current and future issues in plantation industry.

Programme Educational Objectives :-
I) A competent science student with good understanding of fundamental scientific knowledge required for applications in society, environment, industries and further studies.
II) A science student with professional attitudes and ethics necessary in fulfilling his/her responsibilities towards the Creator, client and the society.
III) A science student who is able to adapt him/herself to any educational environment.
Programme Educational Objectives :-

I) A competent science graduate with good understanding of fundamental scientific knowledge required for applications in society, environment, industries and further studies.

II) A science graduate with professional attitudes and ethics necessary in fulfilling his/her responsibilities towards the Creator, client and the society.

III) A science graduate who is able to adapt him/herself to the local as well as global work or educational environment.

IV) A competent semi-professional scientist able to assist technical tasks.

Programme Educational Objectives :-

I) A competent biology graduate with strong understanding of fundamental scientific knowledge.

II) A biology graduate with professional attitudes and ethics necessary in fulfilling his/her responsibilities towards the Creator, client, society and the environment.

III) A biology graduate who is able to adapt him/herself to the local and international work environment.

IV) A biology graduate who is able to lead an organisation based on experience and knowledge of important issues.

V) A biology graduate who is able to initiate and conduct research in his/her own organisation.

VI) A biology graduate who is aware of relevant current and future issues in his/her endeavour.
Programme Educational Objectives :-

I) A competent plantation professional with a good scientific and management knowledge.
II) A plantation professional with good attitudes and ethics necessary in fulfilling his/her responsibilities towards the Creator, client, society and the environment.
III) A plantation professional who is able to adapt him/herself to the international/global work environment.
IV) A plantation professional who is able to lead an organization based on sound experience, knowledge and skills.
V) A plantation professional who is able to conduct research in his/her own organization.
VI) A plantation professional who is aware of relevant current and future issues in plantation industry.

Programme Educational Objectives :-

I) A competent plantation professional with advanced scientific and management knowledge.
II) A plantation professional with good attitudes and ethics necessary in fulfilling his/her responsibilities towards the Creator, client, society and the environment.
III) A plantation professional who is able to succeed in the international/global work environment.
IV) A plantation professional who is able to lead an organization based on sound experience, and advanced knowledge.
V) A plantation professional who is able to manage research in his/her own organization.
VI) A plantation professional who is able to apply relevant issues for advancement of plantation industry.
### Cognitive Domain
**(thinking, knowledge)**

**Lower order**

**Comprehension**
- Definition: Understands the meaning of concepts previously learned material.
- Sample Verbs: define, identify, state, list, name, recall, state.

**Application**
- Definition: Uses learning in new and different situations.
- Sample Verbs: apply, solve, demonstrate, explain, square, paraphrase, give example, translate.

**Analysis**
- Definition: Understands both the content and structure of material.
- Sample Verbs: analyze, compare, organize, summarize, discriminate, evaluate, propose, define.

**Higher order**

**Synthesis**
- Definition: Formulates new ideas from existing knowledge and skills.
- Sample Verbs: combine, construct, design, develop, generalize, propose.

**Evaluation**
- Definition: Judges the value of material or an action performed.
- Sample Verbs: assess, evaluate, judge, interpret, justify, select, report.

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*Based on "Taxonomy of Educational Objectives", B.S. Bloom Editor, 1956*
Psychomotor Domain

(design, skills)

Perception
Definition: Sensory or motor activity.
Sample Verbs: • detect • hear • taste • observe • recognize • see • smell • touch • taste • listen

Guided Response
Definition: Auscultatory stimuli, and physically ready to act.
Sample Verbs: • achieve a posture • assert a body • eliminate a body action • pass, cross, throw, hold • position the body • yawn • stand • sit

Complete Over Response
Definition: Perform tasks without external stimuli, and physically ready to act.
Sample Verbs: • adapt • adjust • accommodate • coordinate • cooperate • comply • comply • practice • possibly • do

Adaptation
Definition: Develops new patterns for specific situations.
Sample Verbs: • design • originate • customize • manipulate • construct

Organization

Affective Domain

(seeing, attitudes)

Receiving
Definition: Affective or emotional stimuli.
Sample Verbs: • accept • adapt • experience • like • prefer • listen • respond • RBI • think about

Responding
Definition: Responds to stimuli.
Sample Verbs: • agree • adapt • show empathy • worry • believe according to • choose • commit • decide • cultivate loyalty • cooperate • coordinate • cope • follow • participate • willingly • make voluntary • modify • persuade • respond • use

Valuing
Definition: Attributes value or worth to something.
Sample Verbs: • adapt • assume responsibility • believe according to • choose • commit • decide • cultivate loyalty • cooperate • coordinate • cope • follow • participate • willingly • make voluntary • modify • persuade • respond • use

Internalizing
Definition: Integrates the value into a value system that controls behavior.
Sample Verbs: • act upon • accept • adapt • adjust • assume responsibility • believe according to • choose • commit • decide • cultivate loyalty • cooperate • coordinate • cope • follow • participate • willingly • make voluntary • modify • persuade • respond • use

Based on “Taxonomy of Educational Objectives”, B.S. Bloom Editor, 1966

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1. Individually, list out 10 attributes of graduates of CHEM/BSAC/ENV
2. Discuss with your neighbour and justify your choices.
3. Agree on 5 of the most important attributes.
4. List out 3 measurable products for each attribute.
5. Discuss with your neighbor and justify your choices
6. Agree on 2 of the most important products for each of the attributes.
Course Outcome PHY407

Towards Lifelong Learning

Course Outcomes: Upon completion of this course, students will be able to:

1. **State, write and explain** the concepts, laws and theories in electrostatics, electricity, magnetism, introductory atomic physics and modern physics. (C-Knowledge) (PO1)

2. **Verbally, visually (pictures & graphs) and algebraically relate and discuss** the concepts, laws and theories in electrostatics, electricity, magnetism, introductory atomic physics and modern physics. (C-Comprehension) (PO1, PO6)

3. **Verify, assess & employ** the concepts, laws and theories in electrostatics, electricity, magnetism, light, introductory atomic physics and modern physics to solve qualitative & quantitative problems visually, algebraically and occasionally, numerically. (C-Application) (PO1)
COURSE: PHY407; Course Outcomes: cont…

4. **Analyze, summarize and discuss** solution to real world problems associated with electrostatics, electricity, magnetism, introductory atomic physics and modern physics. *(for 3rd year course only) (PO1, 6, 8)*

5. **Observe, plan, conduct and justify** scientific investigations in areas of electrostatics, electricity. *(PO3, 5, 6,7)*

6. **Communicate to peers verbally** and to the **facilitator in writing**, the science investigations and justification in areas of electrostatics, electricity and magnetism.

7. **Collaborate, motivate and truthful** with team members and with facilitators in both the labs and in the classroom. *(PO5, 8)*
Learning Outcomes

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(i) demonstrate knowledge and comprehension on fundamental principles of a field of study, acquired from advanced textbooks;
(ii) use the knowledge and comprehension through methods that indicate professionalism in employment;
(iii) argue and solve problems in their field of study;
(iv) show techniques and capabilities to search and use data to make decisions having considered social, scientific and relevant ethical issues;
(v) communicate effectively and convey information, ideas, problems and solutions to experts and non-experts;
(vi) apply team and interpersonal skills which are suitable to employment; and
(vii) possess independent study skills to continue further study with a high degree of autonomy.

MQF Framework for Degree level-Outcomes

Knowledge & Comprehension
- systematic and coherent body of complex knowledge, some of it at the boundaries of an academic discipline
- major studies in which significant literature is available. Course content is taken to a significant depth and progressively developed to a high level which provides a basis for postgraduate study and professional careers.

Intellectual Skills
- analytical techniques and problem solving skills that can be applied in many types of employment, including in a professional
MQF Framework for Degree level-Outcomes

Psychomotor Skills
• Practical skills relevant to the discipline

Generic Skills
• communicate effectively.
• interpersonal and team skills appropriate for employment
• prepared to undertake research, comprehend and evaluate new information and concepts from a range of sources, weigh evidence, arguments and assumptions, to reach sound judgments,
• have developed a foundation for self-directed and life long learning
• exercise of personal substantial responsibility and decision-making in complex and unpredictable circumstances.
• Observation of professional ethics

MQF Framework for Diploma level-Outcomes

Diploma level education balances theory and practice or practical, and stresses on the instillation of values, ethics and attitudes to enable students to:

(i) use knowledge, comprehension and practical skills at work;
(ii) assess and decide, taking into account social, scientific and ethical issues with moderate autonomy;
(iii) be confident and entrepreneurial in pursuing their own careers;
(iv) be responsible members of society;
(v) possess study skills in adapting to ideas, processes and new procedures for career development;
(vi) acquire team and interpersonal skills that are appropriate to employment; and
(vii) communicate effectively and to transmit information, ideas, problems and resolutions cogently to experts and non-experts.
MQF Framework for Diploma level-Outcomes

Knowledge & Comprehension
• breadth, depth and complexity of knowledge for complex skills (degree of emphasis on breadth as against depth of knowledge may vary between qualifications granted at this level)

Intellectual Skills
• substantial degree of judgment for problem solving

Psychomotor Skills
• perform a broad range of complex technical operations

Generic Skills
• Communication & participation in teams
• Exercise responsibility and substantial autonomy for own continuing learning Some exercise of personal responsibility
• work related attitudes and ethics shown in exercise of responsibility and substantial autonomy for own output in work and responsibility for the work of others

MQF Framework for University Preparatory level-Outcomes

Foundation or University Preparatory Course

Foundation Courses or University Preparatory Courses such as Sijil Tinggi Persekolahan Malaysia (STPM), Matriculation and Foundation Certificates are not in the MQF as they are the entry qualifications to universities. Nonetheless, MQF determines standards for these certificates to ensure comparability and standardisation of student abilities. Generally, these are conferred on students who are able to:

(i) show knowledge and comprehension in the field of study that is continued from secondary school as indicated in advanced text books;
(ii) use knowledge and comprehension to identify and use data in respond to concrete and complex problems;
(iii) communicate and clarify understanding and skills to peers and supervisors; and
(iv) demonstrate skills for purposes of pursuing higher education.
Outcome Based Education

**MQF Framework for Preparatory level-Outcomes**

**Knowledge & Comprehension**
- basic concepts of the relevant academic disciplines that enable students to enter Arts or Science based university courses

**Intellectual Skills**
- skills of the different approaches to solving problems

**Psychomotor Skills**
- basic laboratory skills, project work, group work and field activities.

**Generic Skills**
- communicate accurately, effective use of ICT
- Some exercise of personal responsibility

---

Coles (2003) argues that:

A curriculum is more than a list of topics to be covered by an educational programme, for which the more commonly accepted word is a *syllabus*. A curriculum is:

- first of all a policy statement about a piece of education, and
- secondly an indication as to the ways in which that policy is to be realised through a programme of action.
In practice, a working definition of a curriculum is

- the sum of all the activities, experiences and learning opportunities for which an institution (such as the Society) or a teacher (such as a faculty member) takes responsibility – either deliberately or by default. This includes in such a broad concept of curriculum the formal and the informal, the overt and the covert, the recognised and the overlooked, the intentional and the unintentional.

**Designing Curriculum:** curriculum is an academic plan. It is a total blueprint for actions where:

- the objectives (PEOs), outcome (POs) of the curriculum are clarified;
- the processes to achieve these are identified; (course structure & syllabus (content) & instructional strategies)
- the ways to measure whether success has been achieved (assessment); and
- systematic review and adjustment are also part of the plan (evaluation & CQI).
Science programmes must focus on presentations, discussions and practical work that enable students to demonstrate understanding of theory, skills in analysis, ability to speak, write, plan and manage as well as teamwork and leadership.

Industrial training is a must for Applied Science programmes.
Outcome Based Education

Curriculum considers...

Depth (according to year of study in BSc program)
Refers to the levels in the cognitive domain, practical skills & scientific skills.

Cognitive

- Analysis
- Application
- Comprehension
- Knowledge

Year 1
Year 2
Year 3

What is Curriculum

"I do & I remember"

Depth (according to year of study in BSc program)
Refers to the levels in the cognitive domain, practical skills & scientific skills.

Practical & science skills

- Report
  - Data
  - Interpret
- Experiment
  - Manipulate

Practical & science skills

- Procedures
- Hypothesize
- Observe
- Problem

Sample Prep Techniques
- Physical
- Organic
- Inorganic
- General Chem

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Breadth (core, non-core, electives)
Breadth relates to range. This can be defined simply in terms of the different subjects or areas of learning within a programme, but increasingly its definition includes students experiencing a range of:

- teaching and learning styles
- levels of learning and assessment
- assessment types
- learning contexts
- wider activities.

Balance
Balance relates to the relationship between the component parts of the programme. It can be defined simply as the relative proportions of time (notional credit hour) allocated to those components (subjects or areas of learning). It can also be seen as the complementary or contrasting nature of components.
Determining Credit Hours for a course: SLT & Notional Credit

Credit and Academic Load

19. Credit is the quantitative measure that represents the volume of learning or academic load to attain the set learning outcomes.¹

20. Academic load is a quantitative measure of all learning activities required to achieve a defined set of learning outcomes. These activities include lecture, tutorial, seminar, practical, self-study, retrieval of information, research, fieldwork, as well as preparing for and sitting of an examination. In Malaysia, 40 hours of notional student learning time is valued as one credit.²

More breadth than depth, More Practical Skills & Generic Skills Must Map Courses with POs & Designate the Outcome Indicators³
Credit system based on Student Learning Time (SLT)

- SLT - The number of learning hours spent by student for each learning activities need to be identified i.e. learning load – basis of determining the credit for a course

- Credit is the quantitative measure that represents the learning load in order to attain the set of outcomes.

- 1 credit = 40 hrs of Student Learning Time

- Standard Lecture
- New approach
Different writers ascribe different meanings to lifelong education and lifelong learning. One such meaning is:

"The single crucial element in the notion of lifelong education is to be found in the word 'lifelong': it embraces a set of guidelines for developing educational practice ('education') in order to foster learning throughout life ('lifelong'). Lifelong education thus defines a set of organisational, administrative, methodological and procedural measures which accept the importance of promoting lifelong learning."

(Knapper and Cropley, 2000, p.9)

In essence, the basic idea behind the term 'lifelong learning' is that deliberate, focused learning does and should occur throughout a person's lifetime.

Consider the following criteria adapted from Knapper and Cropley: Lifelong learners:

- Plan their own learning
- Assess their own learning
- Are active rather than passive learners
- Learn in both formal and informal settings
- Learn from their peers, teachers, mentors etc.
- Integrate knowledge from different subject areas when required
- Use different learning strategies for different situations.

Achieved through doing research

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### Lifelong Learning Criteria vs. Teaching for Lifelong Learning

<table>
<thead>
<tr>
<th>Lifelong Learning Criteria</th>
<th>Teaching for Lifelong Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students plan their own learning</td>
<td><strong>Formalise the process of planning learning goals collaboratively</strong>—If students can participate in developing their own learning they are more likely to feel internally committed to it. Internal commitment to learning is a hallmark of lifelong learning.</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Lifelong Learning Criteria</th>
<th>Teaching for Lifelong Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students plan their own learning (cont..)</td>
<td>Use formative assessment (i.e. ongoing feedback)—this allows students to experience the learning benefits of assessment. They can uncover errors or deficits and use this knowledge to direct their learning. Develop focused internships—these can give students concrete real world learning goals that they will need to respond to with their own initiative.</td>
</tr>
</tbody>
</table>
It's not what & how much students learn but **HOW**

<table>
<thead>
<tr>
<th>Lifelong Learning Criteria</th>
<th>Teaching for Lifelong Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students assess their own learning</td>
<td>Use self-assessment and peer assessment—students learn to take control of the crucial first step in learning; finding out what it is they do not know. Peer and self assessment assumes assessment is a skill that is vital for students to learn if they are to monitor their learning in</td>
</tr>
</tbody>
</table>

---

Learning in informal settings

Use learning and teaching strategies that start with the students’ present understandings—learning how to learn in informal settings first requires students to value the knowledge they have acquired informally.
It's not what & how much students learn but **HOW**

<table>
<thead>
<tr>
<th>Lifelong Learning Criteria</th>
<th>Teaching for Lifelong Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Learning</td>
<td>Use a research oriented curriculum—where students are seeking knowledge rather than being passive receivers. They learn how to acquire and filter information.</td>
</tr>
<tr>
<td>Peer Learning</td>
<td>Use peer assessment and group learning—this helps students to learn from each other and also develops explicit peer learning skills.</td>
</tr>
</tbody>
</table>

---

It's not what & how much students learn but **HOW**

<table>
<thead>
<tr>
<th>Lifelong Learning Criteria</th>
<th>Teaching for Lifelong Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students integrate knowledge from different disciplines</td>
<td>Problem-Based-Learning is the prime example here, because it usually takes 'messy' real-world problems that almost invariably take the student across discipline boundaries.</td>
</tr>
<tr>
<td>Different learning strategies are used in different situations</td>
<td>Use strategies that stress the learning process at least as much as learning content—here students are explicitly instructed in how to learn. This can incorporate teaching attitudes and skills, and then assessing them,</td>
</tr>
</tbody>
</table>
“I hear & I forget, I see I remember I do and I understand” - Confucious

Active Learning (After the lab & simulation)-Lecture-Discussion

This activity addresses CO1, CO2, CO3 & CO4

Lesson Outcomes: Upon completion of this activity, you will be able to:

1. State & explain the gravitational forces acting on any object.
2. Mathematically represent the gravitational force and describe its impact on physical events.
3. Describe existence of electrical charges in matter and its quantization property.
4. Sketch and explain the charging by induction and charging by contact
5. State & mathematically represent forces acting between electrical charges (Coulomb’s Law)
6. Represent forces acting between charges both pictorially and vectorially.
7. Compare & contrast the similarities and difference of the gravitational field and electric field.

Lesson Outcome PHY407-Labs
Towards Lifelong Learning
Lesson Outcomes: Upon completion of this activity, you will be able to:

1. Draw the electric force diagram exerted by one point charge onto another and describe the motion of charges in the presence of another point charge.
2. Describe how the strength of the force changes when the distance between the charges is varied.
3. Describe and produce a model for the electrical force in terms of the strength and direction that are acting between point charges.
4. Describe and draw the electric field patterns created by a point charge.
5. Produce a relationship between the electric field produced by a point charge and the force it exerts on a test charge.
6. Produce a model for electrical potential produced by point charges and a charged plate.
7. Describe and obtain the relationship between electrical force, electrical field and electrical potential or voltage.

Pre Lab activity:
- Read on the electrical force and electrical field
- Download the vector and electric field simulation from my website

This activity addresses CO5 & CO6

“I hear & I forget, I see I remember
I do and I understand” - Confucious

Lesson Outcomes: Upon completion of this activity, you will be able to:

1. Propose 3 research questions you want to investigate
2. Make some predictions in your investigation.
3. Operationally define the variables involved.
4. Sketch & label the devices used in the experiment.
5. Outline the procedure to conduct the investigation/experiment.
6. Explain the purpose of each of the apparatus used.
7. Conduct a virtual experiment to test your predictions.
8. Communicate and justify orally your findings to your peers.

Pre Lab activity:
- Read on the black body radiation and the photoelectric effect
- Download the photoelectric effect simulation from my website
- List out the 4 observed results in photoelectric effect experiment.

This activity addresses CO5 & CO6
The 3 Domains of Educational Goals

Cognitive (The Head)
Knowledge & Comprehension
Intellectual Skills (Application, Analysis, Synthesis, Creativity & Evaluation)
Psychomotor (Hand) - Practical Skills
Affective (Values, Appreciation & Ethics)

Psychomotor (The Hand)
Affective (The Heart)

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Course outcomes

DOMAINS

Cognitive
- Knowledge
  - Comprehension
    - Definition: Understands both the content and structure of material
    - Sample Verbs: summarize, discuss, explain, illustrate, describe, illustrate, explain, paraphrase, give examples, translate
  - Application
    - Definition: Uses learning in new and concrete situations at a lower level of unstructured situations
    - Sample Verbs: apply, carry out, demonstrate, evaluate, illustrate, summarize, solve
  - Analysis
    - Definition: Analyzes conceptions, compares, contrasts, differentiates
    - Sample Verbs: analyze, contrast, discriminate
  - Synthesis
    - Definition: Synthesizes new products from existing knowledge and skills
    - Sample Verbs: combine, construct
  - Evaluation
    - Definition: Judges the values of material for a given purpose
    - Sample Verbs: assess, evaluate, interpret, justify, select, report

Affective
- Valuing
- Responding
- Receiving

Psychomotor / skills
- Naturalisation
- Articulation
- Precision
- Manipulation
- Imitation

INVOLVES KNOWLEDGE AND THE DEVELOPMENT OF INTELLECTUAL SKILLS

Higher order
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation

Lower order
- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation

Based on “Taxonomy of Educational Objectives”, B. S. Bloom, 1956

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### Bloom’s Taxonomy

#### Categories in the Cognitive Domain

(Taxonomy of Educational Objectives, Bloom, 1956)

<table>
<thead>
<tr>
<th>Level 1 – Knowledge</th>
<th>Defines, describes, identifies, labels, lists, matches, names, outlines, reproduces, selects, states.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eg.</td>
</tr>
<tr>
<td></td>
<td>• List the six levels in the cognitive domain of Bloom’s taxonomy.</td>
</tr>
<tr>
<td></td>
<td>• Define...</td>
</tr>
<tr>
<td></td>
<td>• State the main principles of Theory X.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 2 – Comprehension</th>
<th>Converts, defends, distinguishes, estimates, explains, extends, generalises, gives examples, infers, paraphrases, predicts, rewrites, summarises.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eg.</td>
</tr>
<tr>
<td></td>
<td>• Describe three main features of ...</td>
</tr>
<tr>
<td></td>
<td>• Explain the 3 main components of a learning outcome.</td>
</tr>
<tr>
<td></td>
<td>• Summarise the main causes of the American war in Iraq.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 3 – Application</th>
<th>Changes, computes, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eg.</td>
</tr>
<tr>
<td></td>
<td>• Construct measurable learning outcomes that include lower and higher order cognitive skills for a one-semester course.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 4 – Analysis</th>
<th>Breaks down, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, points out, relates, selects, separates, subdivides</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>e.g.</td>
</tr>
<tr>
<td></td>
<td>• Analyse authentic data from various sources and prepare...</td>
</tr>
</tbody>
</table>

---

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**Outcome Based Education**

**Bloom's Taxonomy**

<table>
<thead>
<tr>
<th>Level 5 – Synthesis</th>
<th>Categorises, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organises, plans, rearranges, revises, rewrites, summarises, tells, writes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g.</td>
<td>Analyst authentic data from various sources and prepare a recommendation report for a specified audience.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 6 – Evaluation</th>
<th>Appraises, compares, concludes, contrasts, criticises, describes, discriminates, explains, justifies, interprets, relates, summarises, supports.</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g.</td>
<td>Evaluate the strengths and weaknesses of the cognitive domain of Bloom's taxonomy in relation to the National Educational Philosophy.</td>
</tr>
</tbody>
</table>

**Psychomotor Domain** (doing, skills)

<table>
<thead>
<tr>
<th>lower order</th>
<th>higher order</th>
</tr>
</thead>
</table>

**Perception**
- Definition: Sensory cues that guide motor activity.
- Sample Verbs:
  - detect
  - hear
  - observe
  - recognize
  - oppose
  - grasp
  - select
  - test
  - inspect
  - watch

**Guided Response**
- Definition: Performs acts with automaticity.
- Sample Verbs:
  - copy
  - duplicate
  - imitate
  - manipulate with ease
  - operate under supervision
  - repeat
  - try

**Mechanism**
- Definition: Performs acts with increasing efficiency, confidence, and proficiency.
- Sample Verbs:
  - complete with confidence
  - conduct
  - demonstrate
  - execute
  - improve with effort
  - increase speed
  - make
  - produce
  - show dexterity

**Complete Overt Response**
- Definition: Adapts and sets to meet a problem situation.
- Sample Verbs:
  - adapt
  - organize
  - adjust
  - overcome
  - change

**Adaptation**
- Definition: Creates new patterns for specific situations.
- Sample Verbs:
  - changes
  - originates
  - contains
  - composes
  - constructs

**Organization**
- Definition: Organizes new patterns for specific situations.
- Sample Verbs:
  - adapts
  - organizes
  - adjusts
  - overcomes
  - changes

**Psychomotor Domain Includes Physical Movement, Coordination & Use of the Motor Skill Areas**

*Based on "Taxonomy of Educational Objectives", B.S. Bloom, Editor, 1956*
**Affective Domain**

*(feeling, attitudes)*

**THINGS EMOTIONALLY (e.g. FEELINGS, INTERESTS, ATTITUDES, APPRECIATION, ENTHUSIASMS, MOTIVATIONS) - THAT MIGHT RESULT FROM INSTRUCTION*

---

**Higher order**

**Organization**

**Definition:** Concretizes the values and principles of a course or an educational system and imparts them through the course.

Sample Verbs: adapt, adjust, arrange, balance, classify, conceptualize, formulate, group, organize, rank, translate.

---

**Internalizing**

**Definition:** Integrates the value into a value system that alters behavior.

Sample Verbs: act upon, accomplish, distract, exemplify, influence, justify behavior, maintain, support, support.

---

**Valuing**

**Definition:** Attaches value or worth to something.

Sample Verbs: adapt, assume responsibility, behave according to, choose, commit, direct, direct, use, value, value, work.

---

**Receiving**

**Definition:** Seeks to assimilate.

Sample Verbs: accept, adapt, adopt, absorb, communicate, complete, confront, cooperate, follow, promote, participate willingly, respond, respond, return.

---

**lower order**

**Responding**

**Definition:** Responds to stimuli.

Sample Verbs: attend, apply, benefit, complete, concentrate, learn, notice, pay attention, tolerate.

---

**Creating a course to achieve specified outcomes requires effort in three domains:**

- planning (identifying course content and defining measurable learning outcomes for it)
- Instruction (selecting and implementing the methods that will be used to deliver the specified content and facilitate student achievement of the outcomes)
- assessment and evaluation (selecting and implementing the methods that will be used to determine whether and how well the outcomes have been achieved and interpreting the results)
Learning Outcomes

3 domains of educational goals (cognitive, psychomotor and affective)

Planning stage

1. What does the course want my students to be able to do as a result of my teaching?

2. What TL activities do I adopt to achieve the intended CO?

Implementation stage

3. Can my students do what the course wants them to be able to do?

Assessment stage

4. Can my students do what the course wants them to be able to do?

First Law of Thermodynamics & Energy Balance – Control Mass, Open System

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Universiti Teknologi MARA

email: drjlani@hotmail.com
http://www2.uitm.edu.my/drjj/index.html
Course outcome for Thermodynamics: (address PO1)
- Write energy balance representing the first law of thermodynamics and use it in both closed and open systems.

Lesson outcomes: Upon completion of this unit, students will be able to:

1. **State** the conservation of energy principle and **name all** the forms of energy entering & leaving a system and energy changes within the system.
2. **Discuss** the energy exchange process and **write** mathematical expressions representing the **energy balance** in units of kJ, for a general system undergoing any process.
3. **Rewrite** the energy balance in the **unit-mass basis** and **unit-time basis** (or rate-form basis) for a general system undergoing any process.

Quotes

"One who learns by finding out has sevenfold the skill of the one who learned by being told."
- Arthur Gutterman

"The roots of education are bitter, but the fruit is sweet." -Aristotle
Energy Conservation

In any process, the total energy must always remain the same. Hence the total energy entering a system must equal the total energy leaving the system.

- Forms of dynamic energies include heat (thermal energy in motion), work done (electrical, shaft, boundary) and mass flow.
- Forms of energy changes within a system include its internal energy, its kinetic energy and potential energy.

Energy Transfer - Heat Transfer

What happens to the properties of the system after the energy transfer?
**Example: A steam power cycle.**

The net work output is

\[ W_{\text{net, out}} = W_{\text{out}} - W_{\text{in}}, \text{ kW} \]

---

**Energy Transfer – Work Done**

Mechanical work:
- Piston moves up
- Boundary work is done by system

Electrical work is done on system

\[ W_{\text{out}} = Vi \Delta V/100, \text{ kJ} \]

\[ W_{\text{e,in}} = Vi, \text{ kJ} \]

\[ W_{\text{e,in}} = Vi \Delta V/100, \text{ kJ} \]
Pipe or duct flow may involve more than one form of work at the same time.

First Law – Energy Transfer

System's initial total energy is

\[ E_1 = U_1 + KE_1 + PE_1 \] or

\[ e_1 = u_1 + ke_1 + pe_1, \text{ kJ/kg} \]
First Law – Energy Transfer

E\textsubscript{1} = U\textsubscript{1} + KE\textsubscript{1} + PE\textsubscript{1}

Movable boundary position gone up

System expands

A change has taken place.

System’s final energy is E\textsubscript{2} = U\textsubscript{2} + KE\textsubscript{2} + PE\textsubscript{2}

A change has taken place.
First Law – Energy Transfer

**Heat as a cause (agent) of change**

How to relate changes to the cause

\[ q_{in}\text{, or } Q_{in} \]
\[ q_{out}\text{, or } Q_{out} \]

System

\[ E_1, P_1, T_1, V_1 \]

To

\[ E_2, P_2, T_2, V_2 \]

\[ \dot{Q}_{in} , kW \]

\[ \dot{Q}_{out} , kW \]

Properties will change indicating change of state

First Law – Energy Transfer

**Work as a cause (agent) of change**

How to relate changes to the cause

\[ W_{in}, \omega_{in}, kJ/kg \]
\[ W_{out}, \omega_{out}, kJ/kg \]

System

\[ E_1, P_1, T_1, V_1 \]

To

\[ E_2, P_2, T_2, V_2 \]

\[ W_{in} , kW \]

\[ W_{out} , kW \]
First Law – Energy Transfer

How to relate changes to the cause

Properties will change indicating change of state

Mass transfer as a cause (agent) of change

\[ \dot{E}_{\text{mass, in}} = (m \varrho)_{\text{in}}, kW \]

\[ (\varrho)_{\text{in}}, \text{kJ} / \text{kg} \]

System

To

\[ E_1, P_1, T_1, V_1 \]

\[ E_2, P_2, T_2, V_2 \]

Mass in

Mass out

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First Law – Interaction Energies

**Energy Balance – The Agent**

\[
E_{\text{in}} = Q_{\text{in}} + W_{\text{in}} + E_{\text{mass, in}}, \text{kJ}
\]

\[
e_{\text{in}} = q_{\text{in}} + \omega_{\text{in}} + \theta_{\text{in}}, \text{kJ/kg}
\]

\[
E_{\text{in}} = Q_{\text{in}} + W_{\text{in}} + E_{\text{mass, in}}; \text{kW}
\]

**For Closed system:** \(E_{\text{mass, in}} = 0, \text{kJ}, \theta_{\text{in}} = 0, \text{kJ/kg}\)

\[
\dot{E}_{\text{mass, in}} = 0, \text{kW}
\]

---

First Law - Interaction Energies

**Energy Balance – The Agent**

\[
E_{\text{out}} = Q_{\text{out}} + W_{\text{out}} + E_{\text{mass, out}}, \text{kJ}
\]

\[
e_{\text{out}} = q_{\text{out}} + \omega_{\text{out}} + \theta_{\text{out}}, \text{kJ/kg}
\]

\[
E_{\text{in}} = Q_{\text{in}} + W_{\text{in}} + E_{\text{mass, out}}; \text{kW}
\]

**For Closed system:** \(E_{\text{mass, out}} = 0, \text{kJ}, \theta_{\text{out}} = 0, \text{kJ/kg}\)

\[
\dot{E}_{\text{mass, out}} = 0, \text{kW}
\]
First Law - System’s Energy

Energy Balance – The Change Within

Energy change within the system, $\Delta E_{sys} = E_2 - E_1$ is the sum of

- Internal energy change, $\Delta U = U_2 - U_1$
- Kinetic energy change, $\Delta KE = KE_2 - KE_1$
- Potential energy change, $\Delta PE = PE_2 - PE_1$

First Law – Energy Change

Energy Balance – The Change Within

$\Delta E_{sys} = \Delta U + \Delta KE + \Delta PE$, kJ

$\Delta e_{sys} = \Delta u + \Delta ke + \Delta pe$, kJ/kg

$\Delta \dot{E}_{sys} = \Delta \dot{U} + \Delta \dot{KE} + \Delta \dot{PE}$, kW

For Stationary system: $\Delta KE = \Delta PE = 0$, kJ

$\Delta ke = \Delta pe = 0$, kJ/kg

$\Delta \dot{KE} = \Delta \dot{PE} = 0$
First Law – General Energy Balance

Energy Balance – General system

\[ Q_{\text{in}} + W_{\text{in}} + E_{\text{mass,in}} - Q_{\text{out}} - W_{\text{out}} - E_{\text{mass,out}} = \Delta U + \Delta KE + \Delta PE, \text{ kJ} \]

\[ q_{\text{in}} + \omega_{\text{in}} + \theta_{\text{in}} - q_{\text{out}} - \omega_{\text{out}} - \theta_{\text{out}} = \Delta u + \Delta ke + \Delta pe, \text{ kJ/kg} \]

\[ \dot{Q}_{\text{in}} + \dot{W}_{\text{in}} + \dot{E}_{\text{mass,in}} - \dot{Q}_{\text{out}} - \dot{W}_{\text{out}} - \dot{E}_{\text{mass,out}} = \Delta \dot{U} + \Delta \dot{KE} + \Delta \dot{PE}, \text{ kW} \]

First Law – Stationary System

Energy Balance – Stationary system

\[ Q_{\text{in}} - Q_{\text{out}} + W_{\text{in}} - W_{\text{out}} + E_{\text{mass,in}} - E_{\text{mass,out}} = \Delta U + 0 + 0 \]

\[ q_{\text{in}} - q_{\text{out}} + \omega_{\text{in}} - \omega_{\text{out}} + \theta_{\text{in}} - \theta_{\text{out}} = \Delta u + 0 + 0, \text{ kJ/kg} \]

\[ \dot{Q}_{\text{in}} - \dot{Q}_{\text{out}} + \dot{W}_{\text{in}} - \dot{W}_{\text{out}} + \dot{E}_{\text{mass,in}} - \dot{E}_{\text{mass,out}} = \Delta \dot{U} + 0 + 0 \]
First Law – Closed System

Energy Balance – Closed System

\[ Q_{in} - Q_{out} + W_{in} - W_{out} + 0 - 0 = \Delta U + \Delta KE + \Delta PE, \text{ kJ} \]

\[ q_{in} - q_{out} + \omega_{in} - \omega_{out} + 0 - 0 = \Delta u + \Delta ke + \Delta pe, \text{ kJ/kg} \]

\[ Q_{\dot{in}} - Q_{\dot{out}} + W_{\dot{in}} - W_{\dot{out}} + 0 - 0 = \dot{\Delta U} + \dot{\Delta KE} + \dot{\Delta PE}, \text{ kW} \]