Outcome-Based Approach to Engineering Education
- Towards EAC Accreditation in 2009

B.Eng. (Hons) Electronics Majoring in Microwave and Communications

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Faculty of Engineering
FOE has been practicing Outcome-Based Education (OBE) approach for the past two years.

The B.Eng Electronics Majoring in Microwave and Communication Program will be assessed by a team from Engineering Accreditation Council (EAC) in July 2009.

EAC is the custodian of OBE practices for engineering degrees and accredits engineering programmes at institutes of higher learning in Malaysia.

Students will be randomly selected by EAC for interview, to obtain feedback about the program.
What Is Outcome Based Engineering Education?

IT’S NOT WHAT WE TEACH, IT’S WHAT YOU LEARN

In a nutshell, learner-centric approach to tertiary education
Contents

• What is EAC?
• Why Need Accreditation?
• EAC Accreditation Criteria
• Deficiencies of Traditional Education
• Outcome Based Education (OBE)
• Roles of Lecturers
• Roles of Students
• Q & A
What Is EAC?

- Formed in 2000, a delegated body from Board of Engineers Malaysia (BEM), the only body for accrediting engineering degree programs.
- Comprises members from BEM, IEM, PSD, and Industry Representatives.

Useful links:
- EAC: www.eac.org.my
- BEM: www.bem.org.my
- MQA: www.lan.govm.my

Statutory body (to be elaborated later)
Roles of EAC

**Engineering Accreditation Council**

- Formulates and updates accreditation policies and criteria.
- Approves guidelines and operating procedures.
- Oversees operational arrangements and appoints evaluation panel.
- Receives evaluation reports and decides on accreditation.
- Responds to complaints, appeals or any proposals for change.
- Oversees development and operation of accreditation and mutual recognition agreement with other countries.
- Fosters the dissemination of developments and best practices in engineering education.
Why Need Accreditation?

Recognition by Malaysian Government, under REGISTRATION OF ENGINEERS ACT 1967 (Revised 2002)

• An accredited engineering degree means the degree is recognized by the Malaysian government.
• It is also a sign of the degree being of high quality and the holder of the degree has already attained a certain level of knowledge, skill and maturity of thought related to the relevant discipline.
• A person with accredited engineering degree may be able to work for the government, as well as private sector.
• He/she may subsequently become a Professional Engineer.
Why Need Accreditation?

*International Mobility (Washington Accord)*

- The Washington Accord (WA): Agreement that establishes equivalence of other countries’ accredited professional engineering programs.

- Accredited Engineering Graduates are recognized by other signatory countries - Possible employment as engineers in those countries without further examinations.
Why Need Accreditation?

**International Mobility (Washington Accord)**

- Established in 1989, as of 2007, the following countries are full members of WA: Australia, Canada, the Republic of Ireland, Hong Kong, Japan, New Zealand, Singapore, South Africa, South Korea, Taiwan, the UK and the USA.

- The following countries are provisional members of the WA and may become a full member in the future: Germany, India, **Malaysia (since 2003)**, Russia, Sri Lanka.
Why Need Accreditation?

Our last accreditation was in 2003 for 5-year programme

Next accreditation visit will be in July 2009
- for intakes of 2005 & onwards

Our programme has been accredited before, so what’s the big deal?

Programmes to be accredited in 2009 will have to be based on OBE approach!

NO OBE = NO ACCREDITATION
EAC Accreditation Criteria

- Academic Curriculum
- **Students**
- **Academic and Supporting Staff**
- Facilities
- Quality Management System
EAC Accreditation Criteria

- **Academic Staff**
  - Academic qualifications
  - Professional qualification, experience & development
  - Research/publication/consultancy
  - Industrial involvement
  - Teaching load/contact hours
  - Motivation and enthusiasm
  - Use of lecturers from industry/public bodies
  - Aware and practice of OBE
Outcome-Based Education (OBE)

• OBE is an educational process that focuses on what students **can do** or the **qualities** they should develop after they are taught.

• OBE involves the restructuring of curriculum, assessment and reporting practices in education to reflect the achievement of high order learning and mastery rather than accumulation of course credits.

• Both structures and curricula are designed to achieve those **capabilities** or **qualities**.

• Discourages traditional education approaches based on direct instruction of facts and standard methods.

• It requires that the students demonstrate that they have learnt the required skills and content.
Why OBE - Deficiencies of Traditional Education

- Provides students with a learning environment with little attention to whether or not students ever learn the material.

- Students are given grades and rankings compared to each other – students become exam oriented or CGPA driven.

- Graduates are not completely prepared for the workforce.

- Lack of emphasis on soft skills needed in jobs e.g. communication skills, interpersonal skills, analytical skills, working attitude etc.
Why OBE - Exam Result is Not the Most Important Consideration by Employer

Employers Rating of Skills/Qualities – 2002

- Communication (verbal & written) 4.69
- Honesty/Integrity 4.59
- Teamwork skills 4.54
- Interpersonal skills 4.50
- Strong work ethics 4.46
- Motivation & initiative 4.42
- Flexibility/adaptability 4.41
- Analytical skills 4.36
- Computer skills 4.21
- Organisational skills 4.05
- Detail oriented 4.00
- Leadership skills 3.97
- Self confidence 3.95
- Friendly/outgoing personality 3.85
- Well mannered / polite 3.82
- Tactfulness 3.75
- **GPA (3.0 or better)** 3.68
- Creativity 3.59
- Sense of humour 3.25
- Entrepreneurial skills/risk taker 3.23
Focus and Benefits of OBE

OBE addresses the following key questions:

• What do we want the students to have or be able to do?
• How can we best help students achieve it?
• How will we know whether they students have achieved it?
• How do we close the loop for further improvement (Continuous Quality Improvement (CQI))? 

Benefits of OBE

• More directed & coherent curriculum.
• Graduates will be more “relevant” to industry & other stakeholders (more well rounded graduates).
• Continuous Quality Improvement (CQI) is in place.
Expectations on Students under OBE – the Outcomes

• Students are expected to be able to do more challenging tasks other than memorize and reproduce what was taught.

• Students should be able to: write project proposals, complete projects, analyze case studies, give case presentations, show their abilities to think, question, research, and make decisions based on the findings.

• Be more creative, able to analyze and synthesize information.

• Able to plan and organize tasks, able to work in a team as a community or in entrepreneurial service teams to propose solutions to problems and market their solutions.
OBE Versus Traditional Education Process

- Traditional education process focuses on the inputs.

Input → Process

- Teaching Staff
- Curriculum
- Labs
- Other Resource

Teaching & Learning

Students at Graduation

- Assessment mainly via exam, test, assignments.
- Quality control from teaching evaluation.
Outcome-Based Education Versus Traditional Education Process

- OBE shifts from measuring input and process to **include** measuring the output (outcome)

  ![Diagram](image)

  - Input
  - Process
  - Teaching & Learning
  - Students at Graduation
  - Graduates to Fulfill Stakeholders’ Satisfaction

  **(Short-term)**
  Program & Subject Outcomes

  **(Long-term)**
  Program Education Outcomes

  - **Stakeholders:**
    - EAC
    - Employers
    - Industry Advisors
    - Academic Staff
    - Public and Parents
    - Students
    - Alumni

- **Teaching Staff**
- **Curriculum**
- **Labs**
- **Other Resource**

- **Assessment by exam, test and assignments.**
- **Assessment of teaching staff, lecture material & flow, results and student ‘capabilities’ (Short & long-term outcomes), lab interview, exit survey etc.**
- **More ‘thinking’ projects, with analysis.**
- **Feedback from industry, alumni and other stakeholders.**
- **Clear continuous improvement step.**
Outcomes in OBE

A Model Hierarchy of Outcomes

Vision and Mission of the Institution/Faculty

Programme Educational Objectives (PEO)

Programme Outcomes (PO)

Learning Outcomes (CO) of Subjects

Long-term Outcomes

Short-term Outcomes

Interrelated and Complement Each Other
**Vision of the University**

To be a premier university that propagates the generation and dissemination of knowledge in cutting edge technologies

**Mission of the University**

1. To deliver quality academic programmes based on state-of-the-art R&D.
2. To attract and nurture quality minds who will contribute towards the global knowledge economy.
3. To inculcate a strong research culture within a dynamic, efficient and effective team of academic and support staff.
4. To be financially self-sustaining via education and the commercialisation of R&D products and services.
Vision and Mission of FOE

Vision of the Faculty
To be a leading engineering faculty for creation, preservation and dissemination of knowledge, training of knowledge workers for nation building, and providing continuous technical support for the ICT industry in Malaysia.

Mission of the Faculty
1. To produce multi-skilled graduates who are able to spearhead nation-building in the Information Age.
2. To provide opportunities and resources for academic and researchers to carry out the state-of-the-art research and development work.
3. To support the growth of nationwide ICT industry through provision of continuous professional development of knowledge.
Programme Educational Objectives (PEO) are long term goals (5 years or more after graduation) describing expected achievements of graduates in their career.

PEO of B.Eng. (Hons) Electronics Majoring in Microwave and Communications

• To develop highly competent engineers specialising in the area of microwave and communications technologies in support of the related industry.

• To produce innovative technical leaders that are able to contribute towards the advancement of microwave and communications technologies.
### Example of how PEOs are linked to the Vision and Mission

<table>
<thead>
<tr>
<th>Vision of the Faculty</th>
<th>Mission of the Faculty</th>
<th>Programme Educational Objectives (PEOs)</th>
</tr>
</thead>
</table>
| To be a leading engineering faculty for creation, preservation and dissemination of knowledge, training of knowledge workers for nation building, and providing continuous technical support for the ICT industry in Malaysia | 1. To produce multi-skilled graduates who are able to spearhead nation-building in the Information Age 2. To provide opportunities and resources for academic and researchers to carry out the state-of-the-art research and development work 3. To support the growth of nationwide ICT industry through provision of continuous professional development of knowledge | 1. To develop highly competent engineers specialising in the area of microwave and communications technologies in support of the related industry.  
- *Related to M1, M2 & M3*  
2. To produce innovative technical leaders that are able to contribute towards the advancement of microwave and communications technologies.  
- *Related to M1 & M3* |
Programme Outcomes (PO) are short term outcomes (at the point of graduation) describing what students are expected to know and be able to perform.

POs of B.Eng. (Hons) Electronics Majoring in Microwave and Communications

1. Ability to acquire and apply fundamental principles of science and engineering.
2. Capability to communicate effectively.
3. Acquisition of technical competence in specialized areas of engineering discipline.
4. Ability to identify, formulate and model problems and find engineering solutions based on a systems approach.
5. Ability to conduct investigation and research on engineering problems in a chosen field of study.
Program Outcomes for B.Eng Electronics Majoring in Microwave & Comm.

POs Cont…

6. Understanding of the importance of sustainability and cost-effectiveness in design and development of engineering solutions.

7. Understanding and commitment to professional and ethical responsibilities.

8. Ability to work effectively as an individual, and as a member/leader in a team.

9. Ability to be a multi-skilled engineer with good technical knowledge, management, leadership and entrepreneurial skills.

10. Awareness of the social, cultural, global and environmental responsibilities as an engineer.

## Example of how POs are linked to the PEOs

<table>
<thead>
<tr>
<th>Programme Educational Objectives (PEOs)</th>
<th>Description of how POs (Programme Outcomes) are linked to the PEOs</th>
</tr>
</thead>
</table>
| 1. To produce all-rounded engineers in the telecommunications technologies in support of the emerging ICT industry | 1. Ability to acquire and apply fundamental principles of science and engineering.  
  - The graduates have firm fundamental knowledge and therefore can easily understand and adapt to any change in the technology  
  - This will ensure that the graduates will be of high caliber equipped with the fundamental technical principles of science and engineering so that they can lead, facilitate and support the development of engineering practices in the industries in Malaysia  
  - Related to PEO 1 |
| 2. To develop capable technical leaders who are able to spearhead the advancement of telecommunications in the country | 2. Capability to communicate effectively  
  - Communication and networking skills are enhanced through presentations, exchanging ideas and arguing with solid rational  
  - To be a good leader, effective communication is a must  
  - Related to PEOs 1 and 2 |
## Outcome-Based Education

### Example of how the course subjects contribute towards POs

<table>
<thead>
<tr>
<th>Programme Outcome</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Basic concepts and theories and their relation to actual engineering systems are applied and extended in Final Year Projects and Industrial Training.</td>
</tr>
<tr>
<td></td>
<td>- Extensive laboratory experiments to provide in-depth practical knowledge and hands-on experience to students.</td>
</tr>
</tbody>
</table>
Learning Outcomes (LO) of subjects are statements of a learning achievement on completion of the subject.

<table>
<thead>
<tr>
<th>LOs of EEN1036 Digital Logic Design:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe the differences between analog and digital systems, and their respective advantages and disadvantages.</td>
</tr>
<tr>
<td>2. Apply positional notations, number systems and computer codes in digital systems.</td>
</tr>
<tr>
<td>3. Apply algebraic methods based on Boolean algebra and truth table to analyse logic circuits.</td>
</tr>
<tr>
<td>4. Apply minimisation methods such as Karnaugh maps and Quine-McCluskey tabular method to simplify switching functions.</td>
</tr>
<tr>
<td>5. Apply the concepts of sequential logic and memory devices in digital systems.</td>
</tr>
<tr>
<td>6. Design modular combinational circuits using encoders, decoders, multiplexers and demultiplexers.</td>
</tr>
</tbody>
</table>
Outcome-Based Education

Course to Program Outcomes Matrix for Courses under the **Electronic Engineering Majoring in Microwave and Communications**

<table>
<thead>
<tr>
<th>CODE</th>
<th>SUBJECT</th>
<th>PO 1</th>
<th>PO 2</th>
<th>PO 3</th>
<th>PO 4</th>
<th>PO 5</th>
<th>PO 6</th>
<th>PO 7</th>
<th>PO 8</th>
<th>PO 9</th>
<th>PO 10</th>
<th>PO 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEM1016</td>
<td>Engineering Mathematics I</td>
<td>80</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>EEM1026</td>
<td>Engineering Mathematics II</td>
<td>80</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>EEM2036</td>
<td>Engineering Mathematics III</td>
<td>80</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>EEM2046</td>
<td>Engineering Mathematics IV</td>
<td>80</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>EEM3068</td>
<td>Random Processes and Queueing</td>
<td>0</td>
<td>5</td>
<td>45</td>
<td>45</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>EEC1016</td>
<td>Circuit Theory</td>
<td>60</td>
<td>10</td>
<td>10</td>
<td>10</td>
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<td>0</td>
<td>0</td>
<td>10</td>
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<td>0</td>
</tr>
<tr>
<td>ECT1026</td>
<td>Field Theory</td>
<td>60</td>
<td>10</td>
<td>10</td>
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<tr>
<td>ECT2036</td>
<td>Circuits and Signals</td>
<td>50</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>EEN1016</td>
<td>Electronics I</td>
<td>60</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>5</td>
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<td>0</td>
</tr>
<tr>
<td>EEN1036</td>
<td>Digital Logic Design</td>
<td>60</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>EEN1046</td>
<td>Electronics III</td>
<td>60</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>10</td>
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</tr>
<tr>
<td>EEN3096</td>
<td>Communications Electronics</td>
<td>30</td>
<td>10</td>
<td>25</td>
<td>15</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ECP1016</td>
<td>Computer and Program Design</td>
<td>40</td>
<td>5</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>ECP1026</td>
<td>Algorithm and Data Structure</td>
<td>40</td>
<td>5</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>
Example of Assessment Methods for Program Outcome 2: Capability to Communicate Effectively

<table>
<thead>
<tr>
<th>Performance Criteria</th>
<th>Subjects</th>
<th>Assessment Methods</th>
<th>Documents to be Kept</th>
</tr>
</thead>
</table>
| • Present and document ideas and experimental results properly documented in a specified format, and supported with evidence. The document must contain explanation with sufficient detail, with minimum grammatical and spelling errors. | • All Subjects- Lab Experiments, FYP, ITP, Mini Projects | • Coursework and exam  
  • presentation of Final Year Project and Industrial Training reports  
  • Lab Reports                                                                 | Exam scripts and assignment  
  Final Year Project and Industrial Training reports and mark sheets, lab reports, |
| • Use multimedia content in oral and visual communication                               | • EPT4046 Final Year Project, EPT4066 Industrial Training  
  • Mini Project  
  • Other Seminars, and  
  • Meetings                                                                 | • Presentation of Final Year Project, Industrial Training,  
  Mini projects and other seminars                                                                 | Final Year Project and Industrial Training, Mini Projects mark sheets,  
  PowerPoint presentation slides. Attendance records in other seminars |
| • Respond to audience’s questions correctly and confidently                            | • EPT4046 Final Year Project, EPT4066 Industrial Training,  
  • EPT3016 Mini Project,  
  other seminars and  
  meetings                                                                 | • Presentation of Final Year Project, Industrial Training,  
  Mini projects and other seminars                                                                 | Final Year Project and Industrial Training, Mini Projects mark sheets,  
  PowerPoint presentation slides. Student attendance records in other seminars |
Outcome-Based Education

Stakeholders’ Mission & Vision

Program Objectives → Program Outcomes → Learning Outcomes of Subjects

Assessment

Analysis

CQI
Continuous Quality Improvement (CQI)

Say what you want

Do what you say

Improve it

Prove it
Roles of Lecturers

- Review PEOs, POs, course structures and syllabi.
- Teach the relevant engineering, maths, and other relevant subjects.
- Conduct relevant tutorials and laboratory practical sessions.
- Give appropriate guide on assignments and projects.
- Conduct empirical measurements of POs.
- Prepare the required documentation.
- Assure EAC and public on the standard of our graduates.
- Obtain and maintain accreditation from EAC through Continuous Quality Improvement (CQI).
Roles of Students

- Know the required Programme Outcomes and Programme Objectives (available at the FOE website).
- For each course, review the Learning Outcomes (available at the FOE website/uploaded in MMLS) at the beginning of each trimester. This gives you an idea of the knowledge and skills expected from a particular course.
- Be more proactive in the learning process to acquire the Learning Outcomes of subjects.
- Demonstrate through the assessment methods that the required skills and knowledge have been acquired.
- Attain the Programme Outcomes and Programme Objectives as a whole during the entire programme.
- Give constructive feedbacks on the programme/course/academic staff to obtain accreditation through active participation in Online Teaching Evaluation, Academic Advisory System, dialog sessions with Dean, etc.
The End

Q & A
References


- TOWARDS EAC ACCREDITATION IN 2009 - Direct Assessment of Program Outcomes, Fakulti Kejuruteraan Elektrik, Universiti Teknologi Malaysia (http://encon.fke.utm.my/OBE.ppt).


Why Need Accreditation?

Governed by *the REGISTRATION OF ENGINEERS ACT 1967 (Revised 2002)*

- Legally, no person is allowed to practice unless he/she is a professional engineer (of one can do it in private sector).

- Professional engineer may use “Ir” before his name OR “PEng” after his name.

- Graduate engineers to register with BEM before taking up employment as an engineer.
Why Need Accreditation?

- Graduate engineers to register before taking up employment as an engineer.

Those who has successfully completed an accredited (recognized) engineering programme

**Professional Engineer** - a graduate engineer who has obtained the prescribed practical experience, passed the Professional Assessment Examination, and satisfied all other requirements of the Board of Engineers (BEM)
### Outcome-Based Education

#### Criteria for International Recognition

**In term of Problem Analysis ….**

<table>
<thead>
<tr>
<th>Washington Accord (Engineers)</th>
<th>Sydney Accord (Technologists)</th>
<th>Dublin Accord (Technicians)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify, formulate, research literature and solve <strong>complex</strong> engineering problems reaching substantiated conclusions using <strong>first principles of mathematics and engineering sciences</strong></td>
<td>Identify, formulate, research literature and solve <strong>broadly-defined</strong> engineering problems reaching substantiated conclusions using <strong>analytical tools appropriate to their discipline or area of specialisation</strong></td>
<td>Identify and solve <strong>well-defined</strong> engineering problems reaching substantiated conclusions using <strong>codified methods of analysis specific to their field of activity</strong></td>
</tr>
</tbody>
</table>
Outcome-Based Education

Criteria for International Recognition

**In term of Depth of Analysis required….**

<table>
<thead>
<tr>
<th>Complex Problems (Engineers)</th>
<th>Broadly-defined Problems (Technologists)</th>
<th>Well-defined Problems (Technicians)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models</td>
<td>Can be solved by well-proven analysis techniques</td>
<td>Can be solved in standardized ways</td>
</tr>
</tbody>
</table>
Expected Changes to Implement OBE

**Course Content** - Reviewing course content to suit specified Learning Outcomes, industrial needs, job specifications, professional body requirement (accreditation), own niche, etc.

**Teaching-Learning Methods** - Introducing innovative/flexible teaching methods/delivery tools to develop PEO and PO in students/graduates.

**Assessment & Evaluation Tools** - Introducing variety of assessment and evaluation tools to measure the achievement of PEO and PO.

**Data & Evidence Collection** - Collecting evidences of process involved and the achievement of the PEO and PO.

**Continuous Quality Improvement** - Closing the loop.
Outcome-Based Education

OBE Assessment Methods

**Direct**
- Exams, assignments, tests, quizzes
- Final year projects
- Laboratory
- Exit interview

**Indirect**
- Industrial training
- Exit surveys
- Course surveys
Outcome-Based Education

Review of PO Achievement

Program Outcomes

Achievement Level (%)