OUTCOME BASED TEACHING & LEARNING

IARE
INSTITUTE OF AERONAUTICAL ENGINEERING

NAAC ACCREDITATION A++ GRADE NBA nirf TOP 200 TOP 100 26 YEARS

Preamble

Outcome-based teaching and learning (OBTL) is an educational theory that focuses on achieving specific goals and outcomes for students. It's a student-centered approach that involves restructuring curriculum, assessment, and reporting practices to reflect mastery and high-order learning rather than course credits. OBTL emphasizes what the learner should get out of the teaching, rather than what the teacher intends to teach.

Objectives

The outcome based teaching learning center is to facilitate the faculty and the students in achieving processes that enable implementation of outcome based education (OBE) and state-of-the-art pedagogy and using latest technology

- Assist Course Coordinators in Designing Course Description /Template.
- Provide Training To The Faculty Members In Delivering State-Of-The-Art Lectures By Improving Pedagogy And Using Latest Technology.
- Support The Students In The Self And Peer Learning Process To Ensure Conceptualization And Meaningful Learning.

OUTCOME-BASED EDUCATION-FRAMEWORK

1. OUTCOME HIERARCHY

2. TEACHING–LEARNING PROCESS

- Collaborative Learning
- Pedagogical Initiatives
- Experiential Learning
- Project-Based Learning
- Research-Based Learning
- Digital Initiatives

3. ASSESSMENT METHODS

Internal Assessment	• Continuous Internal Assessment • Lab Assessment • Project / Review Marks
External Assessment	• Semester End Examination
Feedback Mechanism	• Course End Survey • Program Exit Survey • Alumni & Employer Survey

4. CONTINUOUS IMPROVEMENT

Quality of Learning | Quality of Teaching | Learning Outcomes | Monitoring & Action Plan

Drives Continuous Improvement

> *“It’s not what we teach, it’s what they learn.”*

DEVELOPMENT OF COURSE OUTCOME

CHARACTERISTICS OF EFFECTIVE COURSE OUTCOMES

01 | CLARITY
Describe what you want your students to learn in your course.

02 | ALIGNMENT
Are aligned with program goals and objectives.

03 | MEASURABILITY
Tell how you will know an instructional goal has been achieved.

04 | ACTION-ORIENTED
Use action words that specify definite, observable behaviours.

05 | ASSESSABILITY
Are assessable through one or more indicators (papers, quizzes, projects, presentations, journals, portfolios, etc.)

06 | REALISTIC
Are realistic and achievable.

07 | SIMPLICITY
Use simple language.

COURSE OUTCOMES FORMULA

STUDENTS SHOULD BE ABLE TO

ACTION VERB + BEHAVIOR + RESULTING EVIDENCE

SAMPLE COURSE OUTCOMES

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	Outline common data structures and fundamental algorithms, and familiarise with the associated terminology.	Understand
CO2	Illustrate Abstract Data Types (ADT) in terms of their data structures (strings, stacks, queues, linked lists, hash tables, trees and graphs).	Understand
CO3	Develop programs to implement common algorithms for sorting and searching data.	Apply
CO4	Compare common algorithms for sorting and searching data.	Analyse
CO5	Apply collision resolution techniques to resolve collisions within the hash table.	Apply
CO6	Choose the appropriate data structure to solve real-world problems and to defend the selection.	Apply

PROGRAM OUTCOMES (POs)

PO NUMBER	CATEGORY	DESCRIPTION
PO1	Engineering Knowledge	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop the solution of complex engineering problems.
PO2	Problem Analysis	Identify, formulate, review research literature and analyse complex engineering problems reaching substantiated conclusions with consideration for sustainable development. **(WK1 to WK4).**
PO3	Design / Development of Solutions	Design creative solutions for complex engineering problems and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. **(WK5)**
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. **(WK8)**
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. **(WK2 and WK6).**
PO6	The Engineer and the World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. **(WK1, WK5, and WK7)**
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. **(WK9)**
PO8	Individual and Collaborative Team work	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams. **(WK9)**
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. **(WK8)**

KNOWLEDGE AND ATTITUDE PROFILE (WK) AND INDICATORS OF ATTAINMENT

WK	KNOWLEDGE AND ATTITUDE PROFILE	WHAT IT ENCOMPASSES
WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.	• Concepts of natural sciences (physics, chemistry, etc.) and relevant social sciences applied to solve discipline-specific problems.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.	• Algorithms and numerical methods • Modelling of systems • Data analysis & visualization • Statistical techniques • Computational tools, simulation & modelling • Problem formulation, constraints • Use of IT tools for effective analysis.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.	• Literature review • Problem identification • Model formulation & data collection • Validation of assumptions.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.	• Domain knowledge for evaluation & validation • Standards, innovation & critical analysis • Engineering management principles • Economic decision-making.
WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.	• Sustainable design • Resource efficiency & re-use • Environmental impact & compliance • Net-zero carbon strategies • Feasibility (technical, sustainability, economic, ethical, safety, societal, environmental, cultural) • Communication of solutions with constraints & impacts.
WK6	Knowledge of engineering practice (Technology) in the practice areas in the engineering discipline.	• Selection of tools/resources • Simulation & modelling • Validation & evaluation of results • Integration of measurement systems with engineering design.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.	• Risk identification & management • Public health & safety assurance • Environmental protection & community concerns • Sustainable design, life-cycle analysis • Regulatory compliance & professional responsibility.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.	• Research literature review • Research design & data collection • Data analysis & interpretation • Critical thinking & emerging issues • Ethical research practices • Awareness of quality, standards & industry codes.
WK9	Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.	• Ethical awareness & conduct • Integrity, accountability & transparency • Inclusivity, diversity & respect in practice • Legal responsibilities • Responsible use of technology and resources.

INDICATORS OF ATTAINMENT

PO Number	POS Mapped to WKS	Number of IAs
PO1	WK1 to WK4	15
PO2	WK1 to WK4	15
PO3	WK5	06
PO4	WK8	07
PO5	WK2 and WK6	11
PO6	WK1, WK5, and WK7	11
PO7	WK9	06
PO8	WK 9	06
PO9	WK-1 & WK-9	07
PO10		16
PO11	WK8	13

PSO Number	Indicators of attainment (IA)	Number of IAs
PSO 1	WK 1a, WK 2a, WK 2c, WK 2d, WK 2f, WK 2h, WK 3a, WK 3b, WK 3c, WK 4a, WK 4b	11
PSO 2	WK 2c, WK 2d, WK 2g, WK 2h, WK 3a, WK 3c, WK 4a, WK 6a	08
PSO 3	WK 7a, WK 7b, WK 7c, WK 8b, WK 8e, WK 8f, WK 9a, WK 9b, WK 9c, WK 9f	10

CORRELATION MATRIX OF POS – ECS – WKS – SDGS

POs	ECs	WKs	SDGs
PO1	EC 1	WK-1, WK-2, WK-3, WK-4	SDG-9
PO2	EC 4, 2,10	WK-1, WK-2, WK-3, WK-4	SDG - 1 to 17
PO3	EC 4, EC 5, EC 8,	WK-5	SDG - 1, 2, 3, 6, 10, 11, 12, 13, 14
PO4	EC 5, EC 7	WK-8	SDG - 9
PO5	EC 2, EC 5	WK-1, WK-5, WK 7	SDG - 9
PO6	EC 6, EC 9	WK-1, WK-5, WK 7	SDG - 1 to 17
PO7	EC 9	WK-9	SDG - 5, 10, 16
PO8	EC 8	WK 1,9	SDG - 5, 10, 16
PO9	EC 10,7,12	WK-2,5	SDG - 9
PO10	—	—	SDG - 9, 13
PO11	EC 11	WK-8	SDG - 9, 13

Course outcomes are mapped with PO/PSO

Course Outcome: Machine Learning Techniques

CO1 Explain the fundamental concepts of **Machine Learning** and evaluate supervised learning models using metrics such as **entropy, Gini index**, and **information gain**.

CO2 Apply basic ML algorithms such as **SVM, KNN, MLP, CART**, and **ensemble methods** to solve classification and prediction problems.

CO3 Derive and implement **linear regression** models using **least squares, regularization**, and **Bayesian approaches**, and analyze the bias–variance trade–off.

CO4 Build and compare **probabilistic generative** and **discriminative models** using Bayes theorem, discriminant functions, and Bayesian logistic regression.

CO5 Perform **clustering** and **dimensionality reduction** using K-Means, hierarchical clustering, Gaussian mixtures, EM algorithm, PCA, and LDA.

CO6 Apply **graphical models** (HMMs, Monte Carlo sampling) and apply **reinforcement learning** frameworks for sequential decision-making tasks.

SECTION 11A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	✓	-	-	-	-	-	-	-	✓	✓	-	-
CO2	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	-	✓
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓

CO, PO, PSO Mapped with WKs

Mapping of COs with POs / PSOs and WKs (Attainment & Justification)

COs	POs	WKs (Bloom's Taxonomy Level)									IAs Count
		WK 1 Remember	WK 2 Understand	WK 3 Apply	WK 4 Analyze	WK 5 Evaluate	WK 6 Create	WK 7 Apply	WK 8 Evaluate	WK 9 Create	
		a b c d e f	a b c e f	a b e f	a b c e f	a b c e f	a b c e f	a b c e f	a b c e f	a b c e f	
CO 1	PO 1	● ● ● ●	● ● ● ●	● ● ●	● ●	● ● ● ●	● ●	●			10
	PO 2	● ● ● ●	● ● ●	● ● ●	●		● ●				10
	PO 3			● ● ●	●						4
	PO 11				● ● ●		● ● ●				5
	PSO 1	● ●			●			● ● ●	●		8
	PSO 3	● ● ● ●	● ● ●	● ●	●		● ●	●	●		10
CO 2	PO 1	● ● ● ●	● ● ●	● ● ●							10
	PO 2	● ● ● ●	● ● ●	● ● ●	●						10
	PO 3				● ●						4
	PO 4	● ●			●		● ● ●				5
	PO 5	● ● ● ●	● ● ●					● ●	● ●		9
	PO 11	●			● ● ●		● ●	●			5
	PSO 1	●					● ●		●		8
	PSO 3	● ● ● ●	● ● ●	● ● ●	● ●		● ●	●	●		10

Mapping of COs with POs / PSOs and WKs (Attainment & Justification)

	POs / PSOs	WK 1 Remember	WK 2 Understand	WK 3 Apply	WK 4 Analyze	WK 5 Evaluate	WK 6 Create	WK 7 Apply	WK 8 Evaluate	WK 9 Create	IAs Count
		a b c e f	a b c e f	a b e f	a b c e f	a b c e f	a b c e f	a b c e f	a b c e f	a b c e f	
CO 3	PO 1	● ● ● ●	● ● ●	● ●	● ●						10
	PO 2	● ● ● ●	● ●	● ●			●				10
	PO 3			● ●	● ● ●	●					4
	PO 4				● ● ●	●		●	● ●		5
	PO 5	● ● ●	● ● ●	●		● ●	●	●	●		9
	PO 11			●	● ●						5
	PSO 1	●			● ●						8
	PSO 2	● ● ● ●	● ● ●	● ●	● ●	●	● ●		● ●		10
	PSO 3	● ● ● ●	● ● ●	● ●	● ●			● ●	● ●		10
CO 4	PO 1	● ● ● ●	● ● ●	● ●	● ●	●					10
	PO 2	● ● ● ●	● ● ●	● ●							10
	PO 3			● ●	● ● ●						4
	PO 4				● ● ●	●		●	● ●		5
	PO 5	● ● ●	● ● ● ●				● ●		●		9
	PO 11			●	● ● ●	● ●					5
	PSO 1	●			● ●						8
	PSO 2	● ● ● ●	● ● ●	● ●	● ●	●	● ●		● ● ●		10
	PSO 3	● ● ● ●	● ● ●	● ●	● ●	●		● ●	● ● ●		10

Mapping of COs with POs / PSOs and WKs (Attainment & Justification)

COs	POs / PSOs	WK 1 Remember	WK 2 Understand	WK 3 Apply	WK 4 Analyze	WK 5 Evaluate	WK 6 Create	WK 7 Apply	WK 8 Evaluate	WK 9 Evaluate	IAs Count
		a b c d e f	a b c d e f	a b c d e f	a b c d e f	a b c d e f	a b c d e f	a b c d e f	a b c d e f	a b c d e f	
CO 5	PO 1	● ● ● ● ●	● ●	● ● ●	● ●						10
	PO 2	● ● ● ● ●	● ●	● ● ●					● ●		10
	PO 3			● ● ●	● ●	● ● ●			● ● ● ● ●		10
	PO 4				● ● ●	●	● ●	●			4
	PO 5	●	● ●		● ● ●	● ●					5
	PO 6	● ● ● ●	● ●	●			●		● ●		9
	PO 11				● ● ●				● ●		5
	PSO 1	●		● ●	● ●	● ● ●	●	● ●	● ●	● ●	8
	PSO 2	● ● ● ● ●	● ● ● ●	● ● ●	● ●	● ●	● ●	● ●	● ●	● ●	10
CO 6	PO 1	● ● ● ● ●	● ● ●	● ● ●	● ●						10
	PO 2	● ● ● ● ●	● ●	● ● ●					●		10
	PO 3			● ● ●	● ●	● ● ●	●	●	● ● ● ● ●		10
	PO 4				● ● ●	●	●	●			4
	PO 5	●	● ●		● ●	● ●					5
	PO 6	● ● ● ●	● ●	●			●		● ●		9
	PO 11				● ● ●				● ●		5
	PSO 1	●		● ●	● ●	● ● ●	●	● ●	● ●	● ●	8
	PSO 2	● ● ● ● ●	● ● ● ●	● ● ●	● ●	● ●	● ●	● ●	● ●	● ●	10

Course Articulation Matrix of COs to POs

SECTION 11B: Indicators of Attainment with COs to POs and PSOs

Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs												
	POs										PSOs		
	1	2	3	4	5	6	7	9	10	11	1	2	3
CO1	67	67	67	-	-	-	-	-	-	71	53	-	-
CO2	67	67	67	71	82	-	-	-	-	71	53	-	90
CO3	67	67	67	71	82	-	-	-	-	71	53	90	90
CO4	67	67	67	71	82	-	-	-	-	71	53	90	90
CO5	67	67	67	71	82	-	-	-	-	71	53	90	90
CO6	67	67	67	71	82	80	-	-	-	71	53	90	90

SECTION 11C: Course Articulation Matrix of COs to POs

0	1	2	3
No Contribution (0–5%)	Low (≥5 – <40%)	Moderate (≥40 – <60%)	High (≥60%)

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	3	3	-	-	-	-	-	-	3	2	-	-
CO2	3	3	3	3	3	-	-	-	-	-	3	2	-	3
CO3	3	3	3	3	3	-	-	-	-	-	3	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	3	2	3	3
CO5	3	3	3	3	3	-	-	-	-	-	3	2	3	3
CO6	3	3	3	3	3	3	-	-	-	-	3	2	3	3
Total	18	18	18	15	15	3	-	-	-	-	18	12	12	15
Average	3	3	3	3	3	3	-	-	-	-	3	3	2	3

SECTION 11D: Level of Contribution of the COs to POs and PSOs

0	1	2	3
No Contribution (0–5%)	Low (≥5 – <40%)	Moderate (≥40 – <60%)	High (≥60%)

MECHANISM FOR THE ATTAINMENTS OF CO

CO ATTAINMENT (CIE or SEE)

$$\text{CO ATTAINMENT} = \frac{\text{No. of } \textit{students reached (threshold)} \text{ in answering the question}}{\text{No. of students attempted}} \times 100$$

OVERALL CO ATTAINMENT (DIRECT)

$$\text{Overall CO attainment (Direct)} = 0.30 \times \text{CIA} + 0.70 \times \text{SEE}$$

CO ATTAINMENT (INDIRECT)

$$\text{CO ATTAINMENT} = \frac{\text{No. of students } \textit{responses reached expected level} \text{ in answering the survey}}{\text{No. of students responded}} \times 100$$

WEIGHTAGE OF ATTAINMENT LEVEL

- Direct level 80%
- Indirect level 20%

CO ATTAINMENT

$$0.8 \times \text{CO attainment (Direct)} + 0.2 \times \text{CO attainment (Indirect)}$$

CO ATTAINMENT FRAMEWORK

	Assessment	Tools	Weight
CO Attainment	Direct Assessment	CO attainment of courses	80%
	Indirect Assessment	Course End Survey	20%

KEY TAKEAWAY

CO attainment is calculated by combining direct and indirect assessments using appropriate weightage, ensuring a comprehensive and continuous improvement in teaching–learning outcomes.

MECHANISM FOR THE ATTAINMENT OF CO AND PO/PSO

CO ATTAINMENT (CIE or SEE)

$$\text{CO Attainment (CIE or SEE)} = \frac{\text{No. of students reached (threshold) in answering the question}}{\text{No. of students attempted}} \times 100$$

Measures the extent to which students achieve the expected level in **direct assessments.**

OVERALL CO ATTAINMENT (DIRECT)

$$\text{Overall CO attainment (Direct)} = 0.30 \times \text{CIA} + 0.70 \times \text{SEE}$$

Weighted combination of Continuous Internal Assessment (**CIA**) and Semester End Examination (**SEE**).

CO ATTAINMENT (INDIRECT)

$$\text{CO Attainment (Indirect)} = \frac{\text{No. of students responses reached expected level in answering the survey}}{\text{No. of students responded}} \times 100$$

Measures the extent to which stakeholders perceive the attainment of COs through **indirect methods.**

PO / PSO ATTAINMENT FRAMEWORK

PO / PSO ATTAINMENT

80% of Direct Assessment (CO attainment of courses) + **10%** of Program Exit Survey + **5%** of Alumni Survey + **5%** of Employer Survey =

PO / PSO ATTAINMENT

80% of direct assessment of CO + 10% of Program Exit Survey + 5% of Alumni Survey + 5% of Employer Survey

KEY TAKEAWAY

PO/PSO attainment is calculated by integrating **direct** and **indirect** assessments with appropriate weightage, ensuring a balanced and comprehensive evaluation of program outcomes.

This mechanism ensures **continuous improvement** and alignment with the vision and mission of the institution.

Find out more:
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