**University of Baghdad – College of Engineering**
**Aeronautical Engineering Department**
**Scientific Committee**

# Course Folio

| | |
|---|---|
| ***Module Title:*** | Aircraft Design |
| ***Code Number:*** | AE501 |
| ***Credit Hours:*** | 3 Hours |
| ***Contact Hours:*** | 3 Hours (2 hr. Theoretical, 1 hr. Tutorial and 1 hr. Lab.) |
| ***Pre-requisite(s):*** | Mechanical Design, Aircraft Structures/II |
| ***Co-requisite(s):*** | Wind Tunnels, Computer Aided Design CAD and Engineering Project |
| ***Module Instructor:*** | Assist. Prof. Dr.Ahmed Hameed Kaleel<br>Lecturer of Aeronautical Engineering Dept. /<br>/ College of Engineering / University of Baghdad<br>Tel: +00964-7806573513<br>Email: a.h.alobaidi@coeng.uobaghdad.edu.iq |
| ***Teaching Assistant:*** | ----- |

## *Module Description (or Catalog Data)*

Aircraft design principles blending both synthesis and analysis. The iterative nature of the design process. Applied aerodynamics. Elements of aircraft performance calculation and optimization. Design of aircraft Including payload, crew and avionics provisions, propulsion selection and sizing, aerodynamic configuration optimization, mass properties, stability and control characteristics, and vehicle subsystems. Individual student projects in aircraft design.

## *Textbook and References*

1. **"**Aircraft Design A Systems Engineering Approach (Pb 2016)" by Sadraey
2. "Introduction to Aircraft Design (Cambridge Aerospace Series)" by John P Fielding
3. "Aircraft Design – A Conceptual Approach" by Raymer D P
4. "Introduction to Aircraft Design" by Fielding J
5. Lecture notes

## *Module Goals and Objectives*

1. To develop a detailed understanding of the nature of the design process in Aerospace Engineering.
2. To integrate technical insight into Aerospace configurationally design.
3. To be able to select and use the appropriate tools for the detail design of selected aircraft components.
4. To appreciate the importance of teamwork and group activity to achieve a complete engineering objective.
5. To stimulate awareness of the marketing, costing and business dimension in the Aerospace project.

## ***Module Learning Outcomes***

At the end of the class, the student will be able to:

1. Students will be able to select and be competent in the use of appropriate conceptual design tools and techniques in an aircraft context
2. Students will be able to plan and conduct an experimental flight test and present the analysis of their results in an appropriate manner
3. Students will demonstrate understanding of and be able to show that they have had to make some of the trade-offs that have to be made to come to a realisable and saleable aircraft design
4. Students will be able to select and be competent in the use of appropriate detail design tools and techniques in an aircraft context
5. Demonstrate a thorough understanding of high lift devices on wings
6. Demonstrate a thorough understanding of the relationship between the centre of gravity location and the stability and controllability of conventional aircraft.

## Program Student Outcomes

The ***Aeronautical Engineering Program*** at the Aeronautical Engineering Department / College of Engineering – University of Baghdad adapts the **ABET** seven student outcomes as the main student outcomes of the program. These are:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## Mapping between Module Learning Outcomes and Program Student Outcomes

The following table shows how the ***Module Learning Outcomes*** can achieve and fulfill the ***Program Student Outcomes***:

| Module Learning Outcomes | Program Student Outcomes | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| a | x | | | | | | x |
| b | x | | | | | | x |
| c | x | | | | | | x |
| d | x | | | | | | x |
| e | x | | | | | | x |
| f | | | x | | x | x | |
| g | | | | | x | | |
| h | x | x | | | | | |
| i | | | | X | | | |
| j | | | x | | | | |
| k | | | | | | x | |
| l | | | | | | | |

## Assessments

| | | | |
|---|---|---|---|
| Academic System | √ Modular System | ☐ Annual | |
| Module Assessment for Modular System 100% | Quest | Laboratory Work | Final Examination |
| | Presentations, and Extracurricular Activities) 30 % ( Mid-Term Test, Quizzes, Homework and assignments, Seminars, Oral and ppt. Presentations, and Extracurricular Activities) | \ | 70 % |
| Additional Information | 1. The laboratory experiments are included in the general module (AE309 Aeronautical Engineering Labs./ IV).<br>One Mid-Term test, and (4) Quizzes are usually made. | | |

## Grading System

1. Quizzes:
   - There will be (4) opened books and notes quizzes during the semester.
   - The quizzes will count 10% of the total module grade.
2. Mid-Term Test, and will count 10% of the total module grade.
3. Homework and assignments, and will count 5% of the total module grade.
4. Seminars and oral & ppt. presentations, and will count 5% of the total module grade.
5. Extracurricular Activities, this is optional and will count extra marks (1–5%) for the student, depending on the type of activity.
6. Final Exam:
   - The final exam will be comprehensive, opened books and notes.
   - The final exam will count 70% of the total module grade

## Typical Grading

| | |
|---|---|
| Excellent | 90-100% |
| Very Good | 80-89% |
| Good | 70-79% |
| Fair | 60-69% |
| Pass | 50-59% |
| Poor | <50% |

## *Module Academic Calender*

| Week | Covered Material | H.W. and Assignments | Exams |
|---|---|---|---|
| 1 | **Introduction**<br>-Design and development of aircraft<br>-Design stages<br>-Preliminary design department | | |
| 2 | **Airworthiness**<br>-Definition<br>-BCAR<br>-FAR<br>-Crash airworthiness | | |
| 3<br>4<br>5 | **Fuselage design**<br>-Main characteristics<br>-Fuselage design requirements<br>-Shape of fuselage<br>-Cabin cross section layouts<br>-Cabin cross-section dimensions<br>-Cabin length<br>-Cockpit<br>-Fuselage main dimensions<br>Quick method<br>General method<br>-Fuselage weight<br>Loads and forces in aircraft structures<br>Loads and forces in aircraft structures | H.W.1 | Quiz 1 |
| 6<br>7<br>8 | **Wing design**<br>-Basic requirements<br>-Wing location<br>-Wing geometric characteristics<br>-Evaluation of wing size<br>-Evaluation of SMC<br>-Evaluation of MAC<br>-Analytical method<br>-Graphical method<br>-Diagrammatical method<br>-Airfoils, requirements & definitions<br>-Airfoils coding<br>-High lift devices<br>-Wing aerodynamic characteristics<br>-Lift coefficient increment due to<br>T.E. flaps Split flaps<br>Single slotted flaps Double slotted flaps<br>- Wing weight | H.W.2 | Quiz 2<br><br>Mid-Term Exam |

| | | | |
|---|---|---|---|
| 0<br>01 | **Empennage design**<br>-Tail surfaces functions<br>-Types of surface control system<br>-Tail surface configuration<br>-Horizontal tail plane<br>-Vertical tail plane<br>-Empennage weight | | |
| 02<br>03 | **Under-carriage design**<br>-General requirements<br>-Runways classification<br>-Types of undercarriage<br>-Tailoring u.c. to bearing capacity of A/F<br>-LCN For single wheel<br>-LCN For two or more wheels<br>-Type, size and inflation pressure of tires<br>-Shock absorption. Leg length<br>-Ground load factor<br>-Ground load cases<br>-Structural load cases<br>-Weight of u.c | H.W.3 | Quiz 3 |
| 04<br>05 | **Preliminary weight analysis**<br>-Weight break down<br>-Surface controls group<br>-Engine section or nacelle group<br>-Propulsion group. Engine weight (dry)<br>-Airframe services and equipments<br>-Operational loads<br>-Crew weight<br>-Payload<br>-Fuel weight (based on flight stages)<br>-Fuel weight (based on aircraft type) ( calculation by using graphics) | H.W.4 | Quiz 4 |
| 06 | **Choice of engines**<br>-Take off stages<br>-Computing of static thrust<br>-Computing minimum required thrust | | |
| 07<br>08 | **Center of gravity**<br>-Evaluation of aircraft center of gravity<br>-Loading and balancing diagram<br>-Wing location according to aircraft center of gravity | H.W.5 | |
| 09 | **Payload-Range Diagram** | | Quiz 5 |

## ***Module Policies***

1. Ministry, College, and University regulations apply to this module regarding class attendance,

punctuality, exams, late submissions, absence with permission, penalties for cheating, and policies for assignments and home works.

2. Home works should be submitted one week after assignment, no late homework is accepted.

## Assessment Plan

1. Reinforcement is done through tests, quizzes, homework and assignments, seminars, oral and ppt. presentations, extracurricular activities and student engagement during lectures as shown in the table below.
2. Listing the responses obtained from student survey conducted at the end of academic semester. A students' opinion questionnaire is made for a selected specimen of the students.
3. Students rating performance is made through the results of quizzes and exams related to some of the module outcomes.

## Strategies for Achieving Outcomes and Assessment Methods

| Module Outcomes | Strategies/Actions | Assessment Methods |
|---|---|---|
| **a)** Study aircraft design phases (conceptual, preliminary and details) and weight analysis, wing and fuselage design, tail empennage and Under-carriage, as well as Center of gravity Payload-Range Diagram. | • Lecture plan and in-class activities.<br>• Each class will commence with a summary of the previous lecture.<br>• Questions will be asked and the responses will be used to evaluate the students' understanding of the topics covered.<br>• Oral and power point presentations by the students are made to Participate in the lecture. | • In-class questions and discussion.<br>• Quizzes.<br>• Homework and assignments.<br>• Seminars.<br>• Oral and ppt. presentations.<br>• Lab. Experiments. |
| **b)** Calculate; wing and fuselage dimensions, weight estimation, runway and under carriage design calculation and how to draw Payload-Range Diagram. | • Lecture plan and in-class activities.<br>• Each class will commence with a summary of the previous lecture.<br>• Questions will be asked and the responses will be used to evaluate the students' understanding of the topics covered.<br>• Oral and power point presentations by the students are made to participate in the lecture. | • In-class questions and discussion.<br>• Quizzes.<br>• Homework and assignments.<br>• Seminars.<br>• Oral and ppt. presentations.<br>• Lab. Experiments. |

| | | |
|---|---|---|
| **c)** Be familiar with wings and fuselage design methods, and engine selections, tail empennage and Under-carriage calculations ,payload diagram and center of gravity estimation | • Lecture plan and in-class activities.<br>• Each class will commence with a summary of the previous lecture.<br>• Questions will be asked and the responses will be used to evaluate the students' understanding of the topics covered.<br>• Oral and power point presentations by the students are made to participate in the lecture. | • In-class questions and discussion.<br>• Quizzes.<br>• Homework and assignments.<br>• Seminars.<br>• Oral and ppt. presentations.<br>• Lab. Experiments. |
| d) Understand and apply the principles of (conceptual, preliminary and details) design and similitude to aircraft design problems. | • Lecture plan and in-class activities.<br>• Each class will commence with a summary of the previous lecture.<br>• Questions will be asked and the responses will be used to evaluate the students' understanding of the topics covered.<br>• Oral and power point presentations by the students are made to participate in the lecture. | • In-class questions and discussion.<br>• Quizzes.<br>• Homework and assignments.<br>• Seminars.<br>• Oral and ppt. presentations.<br>• Lab. Experiments. |