# Course Specifications

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|---|---|
| **Program(s) on which this course is given:** | PhD |
| **Department offering the program:** | Aerospace Engineering |
| **Department offering the course:** | Aerospace Engineering |
| **Academic Level:** | Graduate- M. Sc. |
| **Date** | |
| **Semester (based on final exam timing)** | ☐ Fall ☐ Spring |

## A- Basic Information

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|---|---|---|---|---|---|---|---|---|
| **1. Title:** | **Sensor Design** | | | **Code:** | | **Aero 794** | | |
| **2. Units/Credit hours per week:** | Lectures | 2 | Tutorial | 1 | Practical | - | Total | 3 |

## B- Professional Information

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| **1. Course description:** | The course covers fundamental sensor and instrumentation principles for Space systems. Systems discussed include satellite attitude determination sensors, measurement systems for magnetic field, force, temperature, pressure, aerodynamic and navigation sensors.<br>Topics covered in the course are:<br>1- Forces and disturbances affecting space flight; Magnetic field, Van Allen belt, Solar wind, Aerodynamic forces, Gravity force. 2- Space vehicle attitude sensing and measurement 3- Design and Operation of Attitude Sensors: **Sun Sensors**, Earth and Horizon Sensors, Solar Sensors. 4- Measurement and actuation using magnetic field, magnetometers and **magnetic torque** rods. 5-Sensors measuring velocity and angular velocity- AVM devices. 6- Spacecraft Actuation and Control Devices, Reaction wheels, magnetorquers and thrusters. Selection **and Sizing of Reaction wheels**. 7- Other sensors, pressure, temperature, GPS. |
| **2. Intended Learning Outcomes of Course (ILOs):** | **a) Knowledge and Understanding** |
| | Knowledge and Understanding of the forces and disturbances affecting satellite and aircraft motion. Knowledge of the physical laws underlying these forces. |
| | **b) Intellectual Skills** |
| | Ability to design the sensors based on the physical principles studied in the course. |
| | **c) Professional and Practical Skills** |
| | Principles and methodologies for Design, building and testing of instrumentation |
| | **d) General and Transferable Skills** |
| | Matlab (mathematical programming tool) - Simulations- SplidWorks software |

**3. Contents**

| Topic | Total hours | Lectures hours | Tutorial/ Practical hours |
|---|---|---|---|
| 1- Forces and disturbances affecting space flight; Magnetic field, Solar wind, Aerodynamic forces, Gravity force. | 6 | 4 | 2 |
| 2- Space vehicle attitude sensing and measurement- Development of satellite attitude dynamic model. | 9 | 6 | 3 |
| 3- Design and Operation of Attitude Sensors: **Sun Sensors**, Earth and Horizon Sensors, Solar Sensors. | 9 | 6 | 3 |

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|---|---|---|---|
| 4- Measurement and actuation using magnetic field, magnetometers and **magnetic torque** rods. Laws governing magnetic torque. | 6 | 4 | 2 |
| 5-Sensors measuring velocity and angular velocity- AVM devices. | 3 | 2 | 1 |
| 6- Spacecraft Actuation and Control Devices, Reaction wheels, magnetorquers and thrusters. , Selection **and Sizing of Reaction wheels** | 9 | 6 | 3 |
| 7- Other sensors, pressure, temperature, GPS. | 3 | 2 | 1 |
| Total Hours | 45 | 30 | 15 |

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| **4. Teaching and Learning Methods** | Lectures (24 ) | Practical Training/ Laboratory (- ) | Seminar/ Workshop (- ) |
| | Class Activity (- ) | Case Study (6 ) | Projects ( 9) |
| | E-learning (- ) | Assignments /Homework (6 ) | Other: |

**5. Student Assessment Methods**

| • **Assessment Schedule** | **Week** |
|---|---|
| -Assessment 1: Class test | 6th week |
| - Assessment 2: Class assignments (Homework) | Every other week (6 assignments) |
| -Assessment 3; Project Assignment | 4th week |
| -Assessment 4; Presentations | N/A |
| -Assessment 5; Midterm Exam | 8th week |
| -Assessment 6; Final Exam | End of semester |
| • **Weighting of Assessments** | |
| -Mid-Term Examination | 15% |
| -Final-term Examination | 60% |
| -Class assignments (Homework and project) | 15% |
| -Class Test (s) | 10% |
| -Presentation | N/A |
| -Total | 100% |

**6. List of References**

Wertz, Spacecraft attitude determination and control, Kluwer Academic Publishers

**7. Facilities Required for Teaching and Learning**

Projector

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|---|---|
| **Course Coordinator:** | **Prof. Mohamed Bahey Argoun** |
| **Head of Department:** | **Prof. Ayman Hamdy Kassem** |