

| COURSE CODE | COURSE TITLE | L | T | P | C |
|-------------|---------------------------------|---|---|---|---|
| 1152AE130 | Navigation Guidance and Control | 3 | 0 | 0 | 3 |

Course category:

Programme Elective

a. Preamble:

This course aims to introduce basic knowledge on aircraft navigation guidance and control in the view of UAV applications.

b. Prerequisites:

- Linear system Analysis
- Airplane performance

c. Links to other courses

- Hypersonic Aerodynamics
- Rockets & Missiles

d. Course educational objectives

Students undergoing this course are expected:

- To acquire basic knowledge on aircraft navigation and guidance.
- To understand the concepts of control of aircrafts.

e. Course outcomes

Upon the successful completion of the course, students will be able to

| CO Nos. | Course Outcomes | Level of learning domain (Based on revised Bloom's) |
|---------|--|---|
| CO1 | Understand the concept of airplane navigation, guidance and control. | K2 |
| CO2 | Explains various radio systems | K3 |
| CO3 | Gain detailed properties and structure of autopilot systems | K3 |
| CO4 | Explain satellite navigation | K5 |
| CO5 | Explain inertial navigation | K4 |

(K1 – Remember; K2 – Understand; K3 – Apply K4-Analyze, K5 – Evaluate, K6 - Create)

f. Correlation of CO's with programme outcomes (PO)

| CO's | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| CO1 | H | L | | H | | H | H | H | L | | |
| CO2 | H | L | | H | | H | H | H | L | | |
| CO3 | H | L | | H | | H | H | H | L | | |
| CO4 | H | L | | H | | H | H | H | L | | |

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|-----|---|---|--|---|--|---|---|---|---|--|--|
| CO5 | H | L | | H | | H | H | H | L | | |
|-----|---|---|--|---|--|---|---|---|---|--|--|

H- High; M-Medium; L-Low

g. **Course contents**

UNIT I INTRODUCTION 9

Introduction to Guidance and control - definition, Historical background–Introduction to navigation types – Introduction to Inertial Sensors – Mechanical – Ring Laser gyro –Fiber optic gyro – MEMS system

UNIT II AUGMENTATION AND RADIO SYSTEMS 9

Need for automatic flight control systems –Stability augmentation systems –control augmentation systems– Gain scheduling concepts

UNIT III AUTOPILOT 9

Displacement Autopilot –Pitch Orientation Control system– Acceleration Control System–Glide Slope Coupler –Automatic Flare Control –Flight path stabilization – Damping of the Dutch Roll –Methods of Obtaining Coordination – Yaw Orientation Control system –turn compensation– Automatic lateral Beam Guidance– Introduction to Fly-by-wire flight control systems –Lateral control law design using back stepping algorithm.

UNIT IV GPS AND SATELLITE NAVIGATION 9

Introduction to GPS – system description–basic principles –position and velocity determination signal structure –DGPS, Introduction to Kalman filtering–Estimation and mixed mode navigation – Integration of GPS and INS-utilization of navigation systems in aircraft.

UNIT V INERTIAL NAVIGATION SYSTEMS 9

INS components: transfer function and errors –Earth in inertial space –Coriolis Effect – INS Mechanization –Platform and Strap down – Navigation algorithms –INS system block diagram, Different co-ordinate systems – Transformation Techniques –Schuler Tuning - compensation errors – Gimbal lock –Initial calibration and Alignment Algorithms – Ground controlled approach system - surveillance systems-radio altimeter

Total: 45 Hours

Text books

1. Blake Lock, J.H ‘Automatic control of Aircraft and missiles ‘, John Wiley Sons, New York, 1990.
2. Stevens B.L & Lewis F.L, ‘Aircraft control & simulation’, John Wiley Sons, New York, 1992.
3. Collinson R.P.G, ‘Introduction to Avionics’, Chapman and Hall, India, 1996.
4. Garnel.P. &East.D.J, ‘Guided Weapon control systems’, Pergamon Press, Oxford, 1977.

5. Nelson R.C 'Flight stability & Automatic Control', McGraw Hill, 1989.

References

1. BernadEtikin,'Dynamic of flight stability and control', John Wiley, 1972.
2. Myron Kyton, Walfred Fried, 'Avionics Navigation Systems', John Wiley & Sons,2nd edition, 1997 1. Nagaraja, N.S. "Elements of Electronic Navigation", Tata McGraw-Hill Pub. Co., New Delhi, 2nd edition, 1975.
3. George M Siouris, 'Aerospace Avionics System; A Modern Synthesis', Academic Press Inc., 1993.
4. Albert Helfrick, 'Practical Aircraft Electronic Systems', Prentice Hall Education, Career & Technology, 1995.
5. Albert D. Helfrick, 'Modern Aviation Electronics', Second Edition, Prentice Hall Career & Technology, 1994.
6. Sen, A.K. & Bhattacharya, A.B. "Radar System and Radar Aids to Navigation", Khanna Publishers, 1988.
7. Slater, J.M. Donnel, C.F.O and others, "Inertial Navigation Analysis and Design", McGraw-Hill Book Company, New York, 1964.