AE-660: Preliminary Design of Helicopter (Semester II, 2019–20)
Department of Aerospace Engineering, IIT Kanpur

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TW (Helicopter building) 12:00-13:15 pm

Course Objective

To give an introduction to the basics of design of rotary wing and Vertical Take Off and Landing (VTOL) capable vehicles. Design of rotary wing aerial vehicle (manned or unmanned) is radically different from those for fixed wing aircrafts, therefore a systematic coverage of from the most basic concepts is essential. The content of this course would enable students to be able to carry out conceptual design of rotary wing aerial vehicles for specific mission requirements. This includes design and sizing of main rotor and anti-torque systems, performance calculations, tradeoff studies etc.

Further, we would be taking up the problem posed by Vertical Flight Society (VFS) for next years student design competitition as the design problem for the class.

Course Contents

- Introduction to: design process, design goals, types of rotorcraft
- Understanding mission requirements, use of Analytical Hierarchy Process in configuration selection
- Concept selection methodology: collection of statistical data, Pugh's method, key performance indices, life cycle costs
- Generating design alternatives: preliminary sizing using Tischenko's Method, preliminary weight estimation, rotor propulsive efficiency, Lift/Drag ratio, engine performance, main rotor blade weight estimation, rotor hub and swashplate
- Performance: power required for hover, climb, level flight, maximum level speed, speed for best endurance, best range, autorotative performance
- Main rotor configuration design: rotor structural and aerodynamic design (number of blades, rotor diameter, blade chord, rotor inertia, blade twist, blade taper, blade tip shape, sweep, root cutout, tip speed, hinge offset, airfoils, frequency placement, material selection)
- Rotor component design: hub design, control power, helicopter stability considerations; Tail rotor / anti-torque systems: diameter, tip speed, disk area, number of blades, pusher vs tractor
- Fuselage and landing gear design; Vibration sources, vibration reduction
- Life cycle cost estimation: environmental cost, purchase cost, operating cost

References

1. Leishman, J. G., *Principles of Helicopter Aerodynamics*, Cambridge Aerospace Series, 2000.
2. Prouty, R. W., *Helicopter Performance, Stability, and Control*, Krieger Publishing Company, Florida, 1986.

3. Stepniewski, W. Z., and Keys, C. N., *Rotary-Wing Aerodynamics*, Dover, New York, 1984.

4. Venkatesan, C., "Fundamental of Helicopter Dynamics," CRC Press, 2014.

5. Filippone, A., *Flight Performance of Fixed and Rotary Wing Aircraft*, AIAA Education Series, 2006.

Special Emphasis

1. Being able to convert mission or customer requirements to tangible design goals and its priortization.

2. Multi-criteria decision making for configuration selection.

3. Aerodynamics and structural design of rotor, hub and other sub-systems.

4. Performance calculations and iterative design optimization.

Attendance Policy

It goes without saying that 100% attendance is compulsory. Any student who is granted leave by the Convener, DPGC / DUGC also must inform the instructor regarding his/her absence. All announcements for course would be done through class email list.

Attendance Policy

Anytime! Scheduling a appointment through phone / email or WhatsApps is preferred, but you are welcome to walk in to my office at anytime for discussions beyond class hour.

Grading Policy

30%	Midterm Design Report
20%	Weekly reports + Presentations
50%	Final Design Report