ವಿಶ್ವೇಶ್ವರಯ್ಯತಾಂತ್ರಿಕವಿಶ್ವವಿದ್ಯಾಲಯ

ವಿಟಿಯುಅಧಿನಿಯಮ೧೯೯೪" ರಅಡಿಯಲ್ಲಿಕರ್ನಾಟಕಸರ್ಕಾರದಿಂದಸ್ಥಾಪಿತವಾದರಾಜ್ಯವಿಶ್ವವಿದ್ಯಾಲಯ

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

State University of Government of Karnataka Established as per the VTU Act, 1994"JnanaSangama" Belagavi-590018, Karnataka, India

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REGISTRAR

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REF: VTU/BGM/ACA/2023/1397 DATE: 19 JUN 2023

CIRCULAR

Subject: Module rearranged and updated syllabus of 21AE/AS42 regarding...

Reference: email from the Chairperson Board of Studies AE/AS dated 17.06.2023

As a reference to the subject cited above, the Chairperson of the Board of Studies in Aeronautical Engineering has provided an update regarding the subject 21AE/AS42-Aerodynamics, and the syllabus has been attached to this circular for the benefit of the university's stakeholders.

All the Principals of the engineering colleges under the ambit of the University where the Aeronautical Engineering and Aerospace Engineering program has been offered are hereby informed to bring the content of the circular to the notice of all concerned.

Sd/-
REGISTRAR

To,

The principals of engineering colleges under the ambit of the university

Copy to:

1. The Hon'ble Vice Chancellors through Secretary to VC, VTU, Belagavi for kind information.
2. The Registrar (Evaluation) for information and needful
3. The Chairperson BoS in AE/AS or information
4. The QPDS Examination Section VTU, Belagavi for information and needful.
5. The Director (I/c) ITI SMU VTU Belagavi for information
6. Office Copy

REGISTRAR

IV Semester

AERODYNAMICS			
Course Code	**21AE42 / 21AS42**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	3

Course objectives: This course will enable students to

- Understand the basics of fluid mechanics as a prerequisite to Aerodynamics
- Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil and study the incompressible over finite wings
- Understand the concept of compressible flow and acquire the knowledge of shocks & wave formation

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practising the foundational knowledge

Module-1

Two Dimensional Flows & Incompressible Flow Over Airfoil

Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow. Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem and generation of Lift, D-Alembert's paradox, Numericals.

Incompressible flow over airfoils: Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils. Numericals.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT 2. Practising the foundational knowledge

Module-2

Incompressible Flow Over Finite Wings

Biot-Savart law and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory: Downwash and induced drag. Elliptical and modified elliptical lift distribution. Lift distribution on wings. Limitations of Prandtl's lifting line theory. Extended lifting line theory- lifting surface theory, vortex lattice method for wings. Lift, drag and moment characteristics of complete airplane.

Teaching-Learning Process	1. . Teaching in classroom through Chalk, Talk and ICT 2. Practising the foundational knowledge

Module-3

Applications of Finite Wing Theory & High Lift Systems

Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects. Swept wings: Introduction to sweep effects, swept wings, pressure coefficient, typical aerodynamic characteristics, Subsonic and Supersonic leading edges. Introduction to high-lift systems, flaps, leading-edge slats and typical high – lift characteristics. Critical Mach numbers, Lift and drag divergence, shock induced separation, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects. Introduction to Source panel & vortex lattice method.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT 2. Assignment of Home/field work on real-life problem

Module-4

Basics of Compressible Flow

Basics of thermodynamics-definition and basic relation, Energy Equation- For flow and non-flow process, adiabatic energy equation, stagnation pressure, temperature, density, reference velocities, Bernoulli's equation, Effect of Mach number on Compressibility, Isentropic flow with variable area-Area ratio as a function of Mach number, Impulse function, Mass flow rate, Flow through nozzles and diffusers

Teaching-Learning Process	1. . Teaching in classroom through Chalk, Talk and ICT 2. Assignment of Home/field work on real-life problem

Module-5

Normal, Oblique Shocks and Expansion Waves

Governing Equations of Normal Shock Wave. Prandtl relation and Rankine - Hugoniot equation. Oblique shocks and corresponding relations. Shock polar & Hodograph plane. Supersonic flow over a wedge. Supersonic compression and supersonic expansion. Detached shocks. Mach reflection. Intersection of waves of same and opposite families.

Teaching-Learning Process	1. Teaching in classroom through Chalk, Talk and ICT 2. Assignment of Home/field work on real-life problem

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Evaluate typical airfoil characteristics and two-dimensional flows over airfoil
2. Compute and analyse the incompressible flow over finite wings
3. Apply finite wing theory and design high lift systems from the aerodynamics view point

PRACTICAL COMPONENT OF IPCC:

Course objectives: This course will enable students to

1. Be acquainted with basic principles of aerodynamics using wind tunnel.
2. Acquire the knowledge on flow visualization techniques.
3. Understand the procedures used for calculating the lift and drag.

Experiments
Calibration of a subsonic wind tunnel: test section static pressure and total head distributions.
Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.
Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds.
Smoke flow visualization studies on a two dimensional multi element airfoil with flaps and slats at different angles of incidence at low speeds.
Tuft flow visualization on a wing model at different angles of incidence at low speeds: identify zones of attached and separated flows.
Surface pressure distributions on a two-dimensional smooth and rough circular cylinder at low speeds and calculation of pressure drag.
Surface pressure distributions on a two-dimensional symmetric airfoil.
Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag.
Calculation of total drag of a two-dimensional circular cylinder and cambered airfoil at low speeds using pitot-static probe wake survey.
Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness.
Calculation of aerodynamic coefficients and forces acting on a model aircraft at various AOA and speeds using wind tunnel balance (With and Without Yaw).
Pressure measurements on airfoil for a case of reverse flow.

Course outcomes:

At the end of the course the student will be able to:

1. Apply the flow visualization techniques.
2. Estimate the pressure distribution over the bodies.
3. Calculate the lift and drag.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 02/03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks. Marks scorded shall be proportionally scaled down to 50 Marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Text Books

1. Anderson J.D, "Fundamental of Aerodynamics", 5th edition, McGraw-Hill International Edition, New York (2011), ISBN-13: 978-0073398105.
2. Yahya, S.M., "Fundamentals of Compressible flow", Wiley Eastern, 2003

Reference Books

1. Clancy L. J. "Aerodynamics", Sterling book house, New Delhi. (2006), ISBN 13: 9780582988804
2. Louis M. Milne-Thomson, "Theoretical Aerodynamics", Imported Edition, Dover Publications, USA (2011), ISBN 9780486619804.
3. Radhakrishnan, E., "Gas Dynamics", Prentice Hall of India.1995 edition.
4. E. L. Houghton, P.W. Carpenter, "Aerodynamics for Engineering Students", 5th edition, Elsevier, New York. (2010), ISBN-13: 978-0080966328

Web links and Video Lectures (e-Resources):

- .https://nptel.ac.in/courses/101105059

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.