Department of Space Engineering and Rocketry
Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs

Institute Mission

- To educate students at Undergraduate, Post Graduate Doctoral and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry
- To provide excellent research and development facilities to take up PhD programmes and research projects
- To develop effective teaching and learning skills and state of art research potential of the faculty
- To build national capabilities in technology, education and research in emerging areas
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society

Department Vision

To effectively integrate teaching, research and innovation for significant contribution towards National Aerospace Programmes and related activities

Department Mission

- To impart quality education and advanced research training leading to postgraduate and doctoral degree
- To generate modern infrastructure and conducive research atmosphere for carrying out innovative sponsored research projects
- To nurture spirit of excellence and professional leadership in students and faculty members through exposure to leading academic/research organisations and external experts
- To create attractive opportunities for sustained interaction and collaboration with academia and industry

Program Educational Objectives (PEO)

PEO 1: To develop strong foundation in students to understand and analyse advance research problems in Space Engineering and Rocket Science
PEO 2: Nurture professional graduates to develop ability in analysing real life problems of Space Technology

PEO 3: To foster attitude towards continuous learning for developmental activities in research, academia and industry
PEO 4: To improve professional skills for teamwork with ethical awareness and practice in achieving goal

Program Outcomes (PO)

PO 1 : An ability to independently carry out research and development work to solve practical problems in Aerodynamics
PO 2 : An ability to write and present substantial technical report and research article
PO 3 : Students should be able to demonstrate a degree of mastery over and above the bachelor program in the areas of Aerodynamics.
PO 4: Ability to design, perform and interpret data from experiments and correlate them with numerical and theoretical solutions
PO 5 : Students should be committed to professional ethics, responsibilities and norms of practices.
PO 6 : An ability to recognize the need for continuous learning throughout his professional career in the context of technological challenges and advancements

COURSE INFORMATION SHEET

Course code: **SR 613**
Course title: Basics of Measurement
Pre-requisite(s): Experimental Aerodynamics, Basic Electronics (Undergraduate Level)
Co- requisite(s):NA
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: M.Tech
Semester / Level: III/06
Branch: SER
Name of Teacher

Course Objectives

This course enables the students:

A.	To understand the fundamentals of measurement
B.	To describe the quality of measurand and measuring system
C.	To use the different tools for quality and accurate measurement.
D.	To select the different sensors for variety of measurements.
E.	To test acoustical parameters using theoretical as well as instrumental considerations.

Course Outcomes

After the completion of this course, students will be:

1.	Able to discuss fundamental principles of measurement and its system
2.	Able to describe the different tools and features for analog measurements
3.	Able to demonstrate the need for amplifiers, signal conditioning, filters, etc.
4.	Able to select sensors required for pressure, flow, temperature, etc.
5.	Able to organise and perform acoustical measurement.

Syllabus

Fundamentals of measurement: Methods of measurement; Measuring system; Types of input quantities; Standards; Calibration; Error analysis; Uncertainty (estimation, propagation and analysis); sources of error; Chi-squared distribution; Method of least squares; Different types of Sensors and Transducers.

Analog Measurand and Response of measuring system: Simple harmonic relation; Cyclic frequency; Complex relations; Frequency spectrum; Fourier Analysis; Amplitudes of waveform; Amplitude/Frequency/Phase response; Delay, rise time, and slew rate; Response of experimental system elements; Mechanical and electrical elements; Calibration for System response.

Signal Conditioning and Processing: Signal conditioning; Operational amplifiers; Protection; Filtering theory; Active filters; Electronic counters; Analog meters; Multimeter; Cathod ray oscilloscope; Oscillograph; Plotters; Spectrum analyzer.

Measurement of Pressure, Flow and Temperature: Static and Dynamic pressure; Pressure measuring system and transducers; Dynamic characteristics of pressure measuring system; Calibration method; Obstruction meter; Flow meters; Pressure probes; Thermal anemometer; Calibration of flow measuring devices; Pressure thermometer; Thermo resistive elements; Thermocouple; Errors; Measurement of temperature in fluid flow; Measurement of heat flux.

Acoustical measurement: Characteristics of sound; Sound pressure; Sound pressure level; Power; Intensity; Power level; Combination of sound pressure level; Attenuation with distance; Microphones; Sound level meter; Frequency spectrum analyser; DFT; Equivalent sound meter; Sound exposure level; Sound intensity measurement.

Text books:

1. Mechanical Measurements – Bechwith, T. G., Marangoni, R. D., and LienhardV, J. H.. 5th Edition, Pearson Education Asia, ISBN 81-7808-055-9.
2. Mechatronics – Bolton, W., 2nd Edition, Pearson Education, ISBN 81-7808-339-6.
3. Instrumentation, Experiments and Measurements in Fluids- E. Rathakrishnan

Reference books:

4. Handbook of Experimental Fluid Mechanics – Tropia, Yarin and Foss

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus
Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2			1	2	3
CO2	2		1	2	2	2
CO3	3	1	2	2	2	2
CO4	2		2	1		2
CO5	3	2	3	3	2	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD2,CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: SR 614
Course title: Turbulence Modeling in CFD
Pre-requisite(s): Fluid Mechanics, Numerical Analysis, Computational Fluid Dynamics
Co- requisite(s): Nil
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: ME
Semester / Level: III/06
Branch: SER
Name of Teacher:

Course Objectives

This course enables the students:

A.	To know basics of turbulence and numerical techniques to solve the governing equations.
B.	To learn the algebraic models and their application in different flows.
C.	To understand the one and two equation turbulence models and numerical implementation.
D.	To know the Large Eddy Simulation and Direct Numerical Simulation and their advantages and disadvantages.

Course Outcomes

After the completion of this course, students will be able to:

1.	Know the fundamental concepts of turbulence and numerical techniques to solve pdes in fluid flows.
2.	Understand different averaging techniques and RANS equations.
3.	Apply the algebraic turbulence models to solve problems like wall bounded and separated flows.
4.	Learn and implement the one and two equation turbulence models and compare the different models.
5.	Understand the Large Eddy Simulation, Detached Eddy Simulation, Direct Numerical Simulations and their limitations.

Syllabus

Introduction to Turbulence and CFD: Fundamental Concepts of Turbulence, Transition from Laminar to Turbulent Flows, Descriptors of Turbulent Flows, Characteristics of Simple Turbulent Flows, Numerical Techniques to Solve Governing Equations in Fluid Flows, Inviscid Flux Schemes, Boundary Conditions.

[10L]

Basic Equations of Turbulence: Reynolds Averaging, Favre (Mass) Averaging, The Navier-Stokes Equations, Reynolds-Averaged Navier-Stokes (RANS) Equations, Favre- and Reynolds-Averaged Navier-Stokes Equations, Eddy Viscosity Hypothesis, Numerical Implementation of Euler / Navier-Stokes Equations. **[10L]**

Algebraic Models: Molecular Transport of Momentum, The Mixing-Length Hypothesis, Application to Free Shear Flows, Cebeci-Smith Model, Baldwin-Lomax Model, Application to Wall-Bounded Flows, Separated Flows, The ½ Equation Model. **[8L]**

One and Two Equations Models: Baldwin-Barth One-Equation Turbulence Model, Spalart-Allmaras One-Equation Turbulence Model, K- ε Two-Equation Tubulence Model, RNG K- ε Model, k-ω Two-Equation Turbulence Model, SST k-ω Model, Comparison of Various Turbulence Models, Numerical Implementation. **[8L]**

Large Eddy Simulation and Direct Numerical Simulation: Large Eddy Simulation (LES), Spatial Filtering, Filtered Governing Equations, Eddy Viscosity Models, Smagorinsky SGS Model, Dynamic SGS Models, Detached Eddy Simulation (DES), Direct Numerical Simulation (DNS), Advantages and Limitations of LES, DES and DNS. **[8L]**

Text books:

1. Turbulence Modeling for CFD – Wilcox, D. C.

2. An Introduction to Computational Fluid Dynamics – Versteeg, H. K. and Malalasekera, W.

Reference books:

1. Computational Fluid Dynamics: Principles and Applications – Blazek, J.

2. Computational Fluid Dynamics (Vol. III) - Hoffmann, K. A. and Chiang, S. T.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	1	1	1
CO2	2	1	3	1	1	2
CO3	2	2	2	2	1	3
CO4	3	2	3	2	2	3
CO5	3	2	3	2	2	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD2,CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: SR 612
Course title: Aerodynamics of Internal Flows
Pre-requisite(s): Engineering Mathematics, Elements of Aerodynamics, Boundary Layer Theory
Co- requisite(s): Basic Physics, Compressible flows
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: ME
Semester / Level: III/06
Branch: SER
Name of Teacher:

Course Objectives

This course enables the students:

A.	To understand the kinematics and dynamics of vorticity and circulation
B.	To describe the variety of boundary layer equations for different surfaces of diffusers
C.	To classify unsteady, inviscid, compressible flows inside a channel.
D.	To relate starting of flow, effect of friction, heat on the compressible channel flow
E.	To implement flow process in ramjet and scramjet system.

Course Outcomes

After the completion of this course, students will be:

1.	Able to describe fundamental principles of rotational flows in terms of vorticity / circulation
2.	Able to interpret boundary layers and shear layers over different categories of surfaces
3.	Able to classify unsteady channel flows.
4.	Able to relate different influences inside a compressible channel flow
5.	Able to distinguish characters of flow process in a ramjet and scramjet system with heat considerations.

Syllabus

Vorticity and Circulation: Vorticity kinematics and dynamics; Vorticity changes in incompressible and compressible inviscid flows; Circulation behavior in an incompressible and compressible inviscid flow; Rotational flows in terms of vorticity and circulation; Crocco's theorem.

[8L]

Boundary layers and free shear layers: Boundary layer equations for plane and curved surfaces; Laminar, transitional and Turbulent boundary layers; Viscous-Inviscid interactions in a diffuser; Free turbulent flows; Turbulent entrainment; Jets and wakes in pressure gradients.

[8L]

Unsteady flow: Reduced frequency; Examples of unsteady flows; Shear layer instability; System instabilities; Unsteady disturbances in compressible inviscid flow; Oscillating boundary; Oscillating channel; Unsteady boundary layers.

[8L]

Compressible internal flow: Introduction; Effect of friction, heat addition on compressible channel flow; Starting of supersonic diffusers; Characteristics of supersonic flow in passages and channels; Compound channel flows: Flow angle, Mach number, and pressure changes in isentropic supersonic flow; shock boundary layer interaction in internal flows **[8L]**

Flow with Heat addition: Heat addition and vorticity generation; H-K diagram; Flow process in ramjet and scramjet systems; An approximate substitution principle, Flow with heat addition and mixing, Two-stream mixing (constant area, low Mach number, uniform inlet stagnation pressure), Two-stream mixing (non-uniform inlet stagnation pressures), Effects of inlet Mach number level; Applications of the approximate principle (Lobed nozzles, Jets, Ejectors, etc.) **[8L]**

Text books:

1. Internal Flow – Greitzer, E. M., Tan, C. S., and Graf, M. B.
2. Aspects of Internal Flow - Ackeret, J., : in *Fluid Mechanics of Internal Flow*, Sovran, G. (ed.), Elsevier Publishing Company, Amsterdam.
3. Internal Flows - Johnston, J. P., 1978, : in *Turbulence*, Bradshaw, P. (ed.), Springer Verlag, Berlin, 109–172.

Reference books:

4. Boundary Layers in Internal Flow - Performance Prediction - Johnston, J. P., 1986,:, in *Advanced Topics in Turbomachinery Technology*, Japikse, D. (ed.), Concepts ETI Press, Wilder, VT.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus
Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		2		1	3
CO2	2		1	2	2	

CO3	2	3		1		2
CO4	3	2	3			3
CO5	3	2	3	2		3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD2,CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: SR 611
Course title: Fundamental of Turbulence
Pre-requisite(s): Fundamental of Aerodynamics
Co- requisite(s): Nil
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: ME
Semester / Level: III/06
Branch: SER
Name of Teacher:

Course Objectives

This course enables the students:

A.	To understand the origin of turbulence in fluids.
B.	Recognize the turbulence transport equations.
C.	Examine the effect of parametric variation in turbulence.
D.	Understand the flow with and without wall boundaries.
E.	Analyze turbulence using statistics.

Course Outcomes

After the completion of this course, students will be:

1.	illustrating the growth of turbulence in a fluid flow.
2.	Able to describe transport equations related to fluid flow.
3.	Explaining the variation in turbulence due to various factors.
4.	Able to demonstrate the turbulence in free shear and wall bounded flows.
5.	Applying the statistical approach for turbulence realization in a fluid flow.

Syllabus

1. **Turbulence :** Introduction, Nature of Turbulence, Methods of Analysis- Dimensional, Asymptotic and local invariance, Origin, Diffusivity with length and time scale, Eddy Diffusivity

   [8L]

2. **Turbulent Transport :** Reynolds equation, decomposition, mean flow, Reynolds Stress, Introduction to kinetic theory of gases, Estimates of Reynolds stresses, Reynolds stress and vortex stretching, Mixing length model, heat transfer

   [8L]

3. **Dynamics of turbulence:** Kinetic energy of the mean flow, Effect of viscosity, Production and dissipation, Taylor microscale, Spectral energy, Wind tunnel turbulence, Pure Shear Flows, Vorticity dynamics, vector and tensor, Reynolds Stress and vorticity equations, Two dimensional mean flows, Multiple length scales

   [8L]

4. **Free Shear and wall bounded Flows:** Two dimensional flows, plane flows, Cross stream momentum equation, wakes, mixing, Multiple scales- sublayer, velocity defect law, Channel flows, Logarithmic friction law, Effect of pressure gradient

   [8L]

5. **Statistical description, Turbulent Transport, Spectral Dynamics:** Probability density, Effect of spikes and discontinuities, Correlations, Transport in stationary, homogenous turbulence, Diffusion equation, Uniform shear flow, Grid turbulence, one and three dimensional spectra, Three dimensional spectrum, Isotropic relations, effect of production and dissipation **[8L]**

Text books:

1. **A first course in Turbulence – Tennekes and Lumley**
2. **Turbulent Flow – Steven B. Pope**

Reference books:

1. **Turbulence – J. O. Hinze**
2. **Basics of Engineering Turbulence – S. David, K. Ting**

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	3	1	-	-
CO2	2	-	3	2	-	1
CO3	3	1	3	3	2	2
CO4	3	2	3	3	2	2
CO5	3	2	3	3	2	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD2,CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2,CD6
CO5	CD1,CD2,CD6

COURSE INFORMATION SHEET

Course code: SR 615
Course title: Data Acquisition and Processing Lab
Pre-requisite(s): Basics of electronics
Co- requisite(s): Nil
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: M.Tech
Semester / Level: III/06
Branch: SER
Name of Teacher:

Course Objectives
This course enables the students:

A.	To understand the need the data acquisition in the aerospace application.
B.	To remember and recognize the software used in the Data acquisition systems.
C.	To use the hardware and software for simple problems of DAQ.
D.	To analyze the obtained data through various post processing methods.
E.	To design the program for various data acquisition problems.

Course Outcomes
After the completion of this course, students will be:

1.	Recognizing the need of data acquisition systems.
2.	Able to understand the basics of software to be used for DAQ
3.	Solving simple problems of data acquisition.
4.	Able to execute programs and examine the obtained data for DAQ.
5.	Able to design the programs for complex problems of DAQ.

Syllabus

Data Acquisition Lab :

1. Introduction to the Data Acquisition system and Labview.
2. Overview of front and back panel. Simple programming using Labview such as creation of mathematical calculators, obtaining the sine curve in front panel, etc.
3. Introduction to DAQ Assistant, hardware and program to obtain DC voltage from a given source.
4. Obtaining DC voltages from multiple sources, its tabulation and recording.
5. Acquisition of signals in time and frequency domain for single source.
6. Acquire the signals in time and frequency domain for multiple sources.

7. Introduction to Signal conditioning and acquisition of data from strain gages.
8. Post processing of the data using spectral methods.
9. Introduction to output voltages from DAQ (trigger, pulse, continuous source).
10. Controlled operation of DC/ Stepper motor/ PID control using DAQ and Labview.

Text books:

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 % (3 × 10%)
Assignment (s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures

CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	1	2	-	3
CO2	2	-	2	2	-	3
CO3	2	3	3	3	2	1
CO4	2	3	3	3	3	2
CO5	2	3	2	3	2	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD2,CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2,CD6
CO5	CD1,CD2,CD6