FIRST SEMESTER 2017-2018
Course Handout (Part II)

Date: 02/08/2017

In addition to part-I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course No. : **MATH F111**
Course Title : **Mathematics-I**
Instructor-in-charge : **SURESH KUMAR**

Team of Instructors : Amit Kumar, Ashish Tiwari , Bhavya Tripathi, Devendra Kumar, K Satya Pritam, Krishnendra Shekhawat, Parvin Kumari, Pradeep Kr H Keskar, Priyanka Kumari, Satyendra Singh, Srijata Dey, Srikanth, Sumanta Pasari, Swati, Trilok Mathur

1. **Course Description:** The course is intended as a basic course in calculus of several variables and vector analysis. The geometry of objects in two or three dimensional spaces is studied : near a point on them (locally) using differentiation and on the whole (globally) using integration. It includes polar coordinates, convergence of sequences and series, Maclaurin and Taylor series, partial derivatives, vector calculus leading to theorems of Green, Stokes and Gauss.

2. **Scope and Objective of the Course:**
   - Calculus is fundamental to every branch of science and engineering, as all dynamics is modeled through differential and integral equations.
   - Functions of several variables appear frequently in science.
   - The derivatives of the functions of several variables are more interesting because of the several degrees of freedom available.
   - The integrals of the functions of several variables occur in several places such as probability, fluid dynamics, electrical sciences, just to name a few. All lead in a natural way to functions of several variables.
   - The objective of the course is to lay the foundations for these topics.

3. **Text Book:**
   G. B. Thomas Jr., M. D. Weir and J. R. Hass: Thomas' Calculus, 13th Edition, Pearson Educations, 2017.

4. **Reference Books:**
   (i) E. Kreyszig : Advanced Engineering Mathematics, 10th Edition John Wiley and sons 2011.
   (ii) T. M. Apostol : Calculus Vols I and II, 2nd Edition, John Wiley and sons, 1967 and 1969.

5. **Course Plan:**

Module Number	Lecture session/Tutorial Session.	Ref. to text Book: chap/Sec.	Learning Outcome
1. Limits and continuity of real valued function of one real variable	Self Study: Properties of limits, infinity as a limit, continuity	2.3 to 2.6	Understanding of real valued functions of one real variable
2. Infinite sequences and series	L1: Convergence of sequences and series of real numbers L2-L3: Different tests of convergence for the series of non negative terms L4: Absolute and conditional convergence, alternating series	10.1 - 10.8 10.1 is for self study	Differentiate clearly between three types of series convergence with examples and counter examples, Approximating functions with

	L5: Power series, Maclaurin series, Taylor series of functions		polynomials
3. Polar coordinates	L6: Polar coordinates L7-L8: Graphing in polar coordinates L9: Integration using polar coordinates. L10: Polar equations of conic sections	11.3 -11.5, 11.7	The curvilinear coordinate systems like polar coordinates can be more natural than Cartesian coordinates many a times

4. Vector-valued functions	L11: Limit, continuity and differentiability of vector function L12: Arc length, velocity unit tangent vector.	13.1-13.3 (projectile motion excluded)	Understanding of vector valued functions of one variable, motion and its path in space.
5. Motion in space	L13: Curvature, normal vector, torsion L14: TNB frame, tangential and normal components of velocity and acceleration	13.4, 13.5	The relation between the dynamics and geometry of motion.
6. Cylindrical coordinates	L15: Cylindrical coordinates	Additional and advanced exercises, p. 779 (Ex. 8 and 9)	Motions in other coordinate systems.
7. Functions of several variables	L16: Functions of several variables, level curves L17: Limits, continuity	14.1, 14.2	Limits and continuity of functions of several variables is more intricate.
8. Partial differentiation	L18: Partial derivatives L19: Differentiability L20: Chain rule	14.3, 14.4	Difference between ordinary and partial derivatives
9. Directional derivatives, gradient vectors, tangent planes and normal Lines and linearization	L21: Directional derivatives, gradient vectors L22: Tangent planes and normal lines and linearization	14.5, 14.6	Generalizations of partial derivatives and their applications.
10. Extreme values and saddle point of a function of several real varaibles	L23: Maximum, minimum and saddle points of functions of several real variables L24: Lagrange multipliers	14.7, 14.8	Optimization (maximize or minimize) functions of several variables locally as well as globally.
11. Double integrals	L25: Double integrals L26: Areas and volumes L27: Change of integrals from rectangular to polar coordinates	15.1-15.4	Evaluation of area of planar regions and volumes using iterated integrals.

12. Triple integrals	L28-L29: Triple integrals in rectangular, cylindrical and spherical coordinates L30: Substitution in integrals	15.5, 15.7, 15.8	Volumes of solids in space using suitable curvilinear coordinate system.
13. Line integrals of vector fields and Green's theorem in plane	L31: Line integrals L32-L33: Work, circulation, flux, path independence, Potential function, conservative field L34: Green's theorem in plane	16.1-16.4	Different integrals of vector fields on objects in space; applications to flow, flux, work etc.; their mutual relationship via Green's theorem generalizing the fundamental theorem of integral calculus.
14. Surface integrals, Gauss' divergence theorem and Stokes' theorem.	L35-L37: Surface area and surface integral L38-L40: Gauss' divergence theorem, Stokes' theorem.	16.5-16.8 (from sec 16.8 laws of electromagnetic theory and hydrodynamics excluded)	Divergence theorem and Stokes' theorem further generalize Green's theorem.

Note: In tutorials, problems based on the lectures will be practiced, and tutorial tests will be conducted.

6. **Evaluation Scheme:**

EC No.	Evaluation Component	Duration	Marks	Date, Time	Nature of Component
1.	Mid-semester Test	90 minutes	105	12/10 4:00 - 5:30 PM	CB
2.	Tutorial Tests	----------	60	Unannounced	CB
3.	Comprehensive Exam.	3 hours	135	9/12 AN	CB and OB

7. **Make-up Policy**: Make-up for test will be given only for very genuine cases and prior permission has to be obtained from I/C. There is no provision of make ups for tutorial tests.

8. **Chamber consultation hour:** To be announced by the respective Instructor. The chamber consultation hour of all the instructors will be uploaded on Nalanda website.

9. **Notices:** The notices concerning this course will be displayed on Mathematics department notice board and on Nalanda website.

Instructor-in-charge
MATH F111

INSTRUCTION DIVISION
FIRST SEMESTER 2017-2018
(Course Handout Part II)

Date: 02/08/2017

In addition to Part-I (General Handout for all courses appended to the timetable) this portion gives specific details regarding the course.

Course No.: **ME F110**
Course Title: **Workshop Practice**
Instructor-in-charge: **Gajanand Gupta**

Team of Instructors: Gajanand Gupta, K G Daiya, Narpat Ram Sangwa, Neetu Malik, Chetan Jalendra, Kailash Choudhary, Manikandan H, Nitesh Gokhale

☞ **Course description:**

Laboratory exercises involving machining, fitting and joining processes. Casting; metal forming; forging, welding and brazing; metal cutting machines e.g., lathe shaper and planer; drilling milling and grinding;

1. Scope and objective of the Course:

This course aims at imparting practical aspects of the basic techniques and skills used to make/produce/repair metal and wooden products. This course provides basic manufacturing techniques and allied/supporting techniques used to produce finished products from raw materials. Students will be given practical training on various basic manufacturing techniques like machining, forging, casting, sheet metal working, welding, soldering, brazing and other joining techniques using common machine tools, hand tools and other equipments. Various joining and fitting skills will also be imparted in the practical classes.

2. Books:

Textbook

(i) Sangwan K S , Rao C R and Daiya K G, *Practical Manual for Workshop Practice*, EDD, BITS Pilani.

(ii) B S Nagendra Parashar and R K Mittal, *Elements of Manufacturing Processes*, Prentice Hall of India, 2006, 4th print.

Reference Book

Campbell J.S., *Principles of Manufacturing Materials and Processes*, Tata Mc-Graw-Hill, New Delhi, 23rd reprint 2006.

3. Course Plan:

S. No.	Type of Lab/Shop	Topics to be covered	No. of turns
1	Fitting	Fitting tools and equipments, basic fitting operations, fabrication of a metal job using fitting skills	3
2	Welding	Welding tools and equipments, common types of welding, welding techniques, fabrication of joints using arc welding and gas welding	3
3	Smithy	Smithy tools and equipments, smithy operations, preparation of a simple job using hot forging skills	1
4	Sheet metal	Sheet metal tools, sheet metal operations, development and fabrication of a job using sheet metal operations	2
5	Carpentry	Carpentry tools and equipments, preparation of a wooden job using various joints	3
6	Machining on lathe	Main parts of a centre lathe, work holding devices, cutting tools, operations on a centre lathe, machining of a metal job using a centre lathe, Operating parameters	3
7	Machining on shaper	Main parts of a shaper, work holding devices, machining of a metal job using a shaper, Operating parameters	2
8	Machining on milling	Main parts of milling, milling cutters, machining of a metal job on a milling machine, Operating parameters	1
9	Grinding	Types of grinding machines and their main parts, demonstration of simple grinding on centreless, surface, cylindrical, and tool & cutter grinder, Operating parameters	1
10	CNC machining	CNC fundamentals, demonstrations on CNC turning and milling centres, Operating parameters	1
11	Metrology	Common measuring instruments used in workshop, experiments to find the angle of a dovetail, angle of a taper and the radius of a circular surface	1
12	Foundry	Common foundry tools and equipments, preparation of a green sand mould	1
13	Rolling	Objective of rolling, rolling process, practical on two high rolling mill	1
14	Electroplating	Electroplating a given job	1

4. Evaluation Scheme:

S. No.	Component	Duration	Weightage	Date & time	Nature
1	Practical	--------	70% (210 Marks)	Continuous	-
2	Comprehensive Quiz		30% (90	<TEST_C>	CB

			Marks)		

5. **Make-up Policy:**
   - At most **two genuine make-up** will be allowed with **prior permission**. All make-up requests are to be made to **Mr. K. G. Dhayia** with relevant documents.
   - **No makeup will be given for Comprehensive Quiz Examination.**

6. **Notices:** All notices concerning the course will be displayed on **Workshop notice board** only.

Instructor-in-charge
ME F110

First Semester 2017-2018
Course Handout (PART-II)

Date: 02/08/2017

In addition to part I (General handout for all courses appended to the timetable) this portion gives further details regarding the course.

Course No. : *PHY F110*

Course Title: *Physics Laboratory*

Instructor In-charge: **Amol Holkundkar**

Instructors Name :
Aditi Mandal, Anshuman Dalvi, Arghya Maity, Biswanath Layek, Captain Rituraj Singh, D Bandyopadhyay, D D Pant, Dinachandra Singh, Ishan Mata, J N Bandopadhyay, Kaushar Vaidya, Kusum Lata, Madhukar Mishra, Navin Singh, Neelakshi Sharma, Parul Taneja, Prachi Venkat, Pradeep Kumar Yadav, Raj Kumar Gupta, Rakesh Choubisa, Rishikesh Vaidya, RR Mishra, Shivani Choudhary, Sumita Choudhary, Tridev A Mishra

1. Aims and learning objective:
The main aim is to expose the students to experimental methods of physics and to integrate theoretical knowledge and concept to practical experience. Students will learn, operation of scientific equipment for collecting data and the analysis of collected data using computer.

2. Text Book:
Laboratory manual written by the faculty members of physics department is available in physics department web page and also will be uploaded on Nalanda.
Reference: Relevant reference materials are specified in the lab manuals.

3. Evaluation Scheme:

Evaluation components	Duration	Marks	Day, Time and Venue
Day-To-Day Performance	Normal class hours	120	Regular Lab Hour
Mid term test	30 mins	30	<TEST_1>
Comprehensive examination	2 hours	90	<TEST_C>
Lab test	1 hour	60	TBA
Total		300	

*TBA: To be annouced.

4. Important Instructions to the students:

(a) Day to day performance would carry 15 (10 for Performing Experiment and 5 for results/graphs) marks for each experiment.
(b) We will take the best (n-1) experiments (where n is the total number of experiments performed by a particular Section during the semester) while doing the evaluation at the end of the semester. Total marks for day to day performance would be scaled down to 120 marks.
(c) Students would perform 1 experiment per turn and submit the calculations and the results on the next turn in the prescribed "observation booklet". They need to keep their this observation booklet on the instructor's desk, before they start next experiment. If they fail to do so, 3 marks per experiment would be deducted from day to day performance for that experiment.
(d) Students are expected to read about the allotted experiments from the manuals before coming to the Lab and should carry the hard copy of the observation booklet (record) with them.
(e) Students are expected to maintain laboratory discipline during the lab hour. They can be penalized for any indiscipline in the lab.

5. Responsibilities of the students:

(a) To carry his/her valid identity card issued by the institute.
(b) To sign attendance sheet.
(c) To arrive at the laboratory in time.
(d) To get one reading in the observation table verified and attested by the instructors.
(e) To understand and strictly follow the safety precautions.
(f) To complete the experiment on time.
(g) To not indulge in any unfair means in the evaluation component. Institute has very strict policy on plagiarism. If it is observed that the readings and results are copied from any other sources, then no marks for that experiment

would be awarded.

6. Make-up policy:

The schedule of the experiment is very tight; the students are expected to attend all the laboratory sessions regularly. Make up, if any, will be decided after the consultation with the lab instructor and the genuineness of the missing purpose. No makeup would be granted during the regular lab hours. Makeup will be granted at the end of the semester based on the recommendation of the respective instructor.

6. Notices:

Notices concerning this course will be displayed on Physics Dept./FD-III notice board and NALANDA.

Instructor-In-Charge:
Amol Holkundkar

FIRST SEMESTER 2017-18
INSTRUCTION DIVISION
Course Handout (Part II)

Date: 27/07/2017

In addition to part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the courses.

Course No	:	BITS F110
Course Title	:	ENGINEERING GRAPHICS
Instructor-in-charge	:	**SHUVENDU NARAYAN PATEL**
Team of Instructors	:	Kamlesh Kumar, Durgesh Vikram, Vishakha Sakhare, Gaurav Kumar, Manpreet Singh, Nilesh Purohit, Nitesh Sihag, Rohit Gunerkar, Tanmay Gupta, Vasanth Keshav, Vidhi Vyas, Kiran Raj K, Vivek Tiwari,

1. Course Description:

The course includes fundamentals and techniques of technical drawing and also standard practices of the same so that design ideas can be adequately communicated and produced. It introduces students to theories of projection and the concepts of engineering drawing using the most widely used CAD application software AutoCAD. Basic AutoCAD 2014 commands will also be introduced.

The course will cover: Introduction to AutoCAD basic commands; theory of projections; orthographic projections; isometric projections; projection of points, lines, planes and solids; section of solids; developments of surfaces; interpenetration of solids.

2. Scope and objective of the course:

Computerized drafting is an upcoming technology and provides accurate and easily modifiable graphics entities, easy data storage and retrieval facility and enhances creativity.

Upon successful completion of this course, the student will be able to:

- Read and interpret engineering drawings
- Identify the three principal projection planes
- Draw 2-dimensional orthographic projections from given 3-dimensional views
- Create an isometric drawing using AutoCAD
- Comprehend orthographic and multiview projection

- Apply the concept of cutting planes to create the various types of sectional views
- Become conversant with appropriate use of AutoCAD software for drafting.

3. Text Book: D.M. Kulkarni, A.P. Rastogi and A. K. Sarkar., *Engineering Graphics with AutoCAD*, PHI Learning Private Limited, New Delhi.

4. Reference Book: Dhananjay A. Jolhe, *Engineering Drawing with an Introduction to AutoCAD*, Tata McGraw-Hill Education Private Limited, New Delhi.

5. Course Plan:

Module Number	**Lecture session/Tutorial Session.**	**Reference**	**Learning Outcome**
1. Introduction on Engineering Graphics, Intro to AutoCAD,	L1.1. Introduction on Engineering Graphics. Basic Commands.	Ch-1	Opening of AutoCAD file, Saving, Editing etc., Basic Commands of drawing, editing.
	L 1.2. Further Basic Commands.	Ch-2	
	P1.1. To play around with AutoCAD software and to run the various commands (Non-Evaluative)	Ch-2	
	P1.2. Questions from different Plates of the book will be given. (Non-Evaluative)		
	P1.3. Questions from different Plates of the book will be given. (Non-Evaluative)		
	P1.4 Questions from different Plates of the book will be given. (Non-Evaluative)		
2. Orthographic projections	L2.1 Theory, techniques, first and third angle projections,	Ch-3 and Ch-5	For the given objects(pictorial views) one can draw the

	L2.2. Multi view drawing from given pictorial views.		orthographic projections.
	P2.1. Practice question will be given/discussed in 1st 45 minutes. Evaluative questions will be given and the submission should be done within the next 45 minutes. (Evaluative)	Ch-5	
	P2.2. In a similar way as the above Practical Class. (Evaluative)		
3. Isometric Drawing	L3.1. Theory of isometric drawing	Ch-6	One can learn how to draw the isometric drawing with the given orthographic views.
	L3.2. Construction of isometric from orthographic.		
	P3.1. Practice question will be given/discussed in 1st 45 minutes. Evaluative questions will be given and the submission should be done within the next 45 minutes. (Evaluative)		
	P3.2. In a similar way as the above Practical Class. (Evaluative)		
	P3.3. In a similar way as the above Practical Class. (Evaluative)		

4. Spatial geometry	L4.1 Projection of points; lines, true lengths, inclinations, shortest distance;	Ch-9	One can learn the projection of lines and projection of surfaces.
	L4.2. Projection of Planes	Ch-10	
	P4.1. Practice question will be given/discussed in 1st 45 minutes. Evaluative questions will be given and the submission should be done within the next 45 minutes. [Projection of lines] (Evaluative)	Ch-9	
	P4.2. In a similar way as the above Practical Class. [Projection of lines] (Evaluative)		
	P4.3. In a similar way as the above Practical Class. [Projection of Planes] (Evaluative)	Ch-10	
	P4.4. In a similar way as the above Practical Class. [Projection of Planes] (Evaluative)		
5. Geometrical solids and sections	L5.1. Projections of solids;	Ch-12	How to draw the projection of solids and the sectional views of solids.
	L5.2. Section planes and sectional view of Solids.	Ch-13	

	P5.1. Practice question will be given/discussed in 1st 45 minutes. Evaluative questions will be given and the submission should be done within the next 45 minutes. [Projection of Solids] (Evaluative)	Ch-12	
	P5.2. In a similar way as the above Practical Class. [Projection of Solids] (Evaluative)		
	P5.3. In a similar way as the above Practical Class. [Projection of Section of Solids] (Evaluative)	Ch-13	
	P5.4. In a similar way as the above Practical Class. [Projection of Section of Solids] (Evaluative)		
6. Development of surfaces	L6.1. Radial line method	Ch-14	One can learn how to develop the external surfaces of the given objects.
	L6.2. Parallel line method		
	P6.1. Practice question will be given/discussed in 1st 45 minutes. Evaluative questions will be given and the submission should be done within the next 45 minutes. (Evaluative)	Ch-14	

	P6.2. In a similar way as the above Practical Class. (Evaluative)		
7. Interpenetration of Solids	L7.1. Vertical interpenetration, horizontal interpenetration.	Ch. 15	The projection of interpenetrated solids and intersected solids can be drawn. The profile drawing at entry and exit sides of intersected solid can also be learnt.
	L7.2. Drawing of profile at entry and exit sides of intersected solid.		
	P7.1. Practice question will be given/discussed in 1st 45 minutes. Evaluative questions will be given and the submission should be done within the next 45 minutes. (Evaluative)	Ch. 15	
	P7.2 Practice (Non-Evaluative)		
	P7.3. In a similar way as the above Practical Class. (Evaluative)		

6. Evaluation Scheme:

EC No.	Evaluation component	Duration	Weightage	Date, Time	Remarks
1	Mid – Test (On-line)	60 min	25%	-	**CB**, On-line (Exam schedule shall be announced in class)
2	Comprehensive (On-line)	75 min	40%	10/12 FN	**CB**, On-line (Exam schedule shall be announced in class)

3	Assignments	Practical Hours	35%		**OB**, Best (n-3) performances will be counted for aggregate marks.

7. Chamber Consultation Hours: To be announced in class by individual instructors.

8. Notices: Concerned notices will be displayed on LTC notice board and INTRABITS.

9. Make-up policy: There is no makeup for class assignment. Make-up request for Mid Semester / Comprehensive examination must accompany appropriate supporting medical / exigency documents.

10. Mid Semester/Comprehensive Examination will be conducted throughout the day need not be in the allotted slots as per Time-Table. So the students should be available for the whole day.

Instructor-in-Charge
BITS F110

SECOND SEMESTER 2017-18

Course Handout (Part – II)

Date: 08/01/2018

In addition, to Part I (General handout for all course appended to timetable), this portion gives further specific details regarding the course.

Course No.	:	BITS F111
Course Title	:	Thermodynamics
Instructor-in-Charge	:	**Sachin U.Belgamwar**
Instructors :		Aakash Chand Rai, Arindam Das, BhanuVadhan Reddy, D. D. Pant,Indresh Kumar, Keyur Joshi,Kiran Raj, MuraliPalla, Navin Singh, Prashant U Manohar,Priya C Sande, Ramkinkar Roy, Santosh Saraswat, ShyamSudar Yadav, SimachalKar,Vivek Tiwari

Course Description

Concepts and laws of thermodynamics; thermodynamic properties; applications to closed and open systems; entropy and entropy generation; availability.

1. Scope and Objective

Thermodynamics deals with energy, matter, and the laws governing their interactions. It is essential to learn its usefulness in the design of processes, devices, and systems involving effective utilization of energy and matter. The course emphasizes on the fundamentals and concepts of the laws of thermodynamics as applied to control mass and control volume systems. Irreversibility and availability are powerful tools in the design of thermodynamic systems.

2. Text book (TB):

Sonntag R.E. and BorgnakkeC., "Fundamentals of Thermodynamics", John Wiley & Sons, 2009, 7th ed.

Booklet on Thermodynamic Tables, Figures & Charts Notes EDD - 2007

3. Reference books (RB):

Çengel Y.A. and Boles M.A., "Thermodynamics: an engineering approach",Tata Mcgraw-Hill, 2010, 6th ed.

Moran M. J., Shapiro H. N., Boettner D. D and Baily M. B., "Principles of Engineering Thermodynamics", Wiley,2010, 7th Ed.

4. Course Plan

Lecture No.	Learning Objectives	Topics to be covered	Text book Chap/Sec #
1-2	Some concepts & definitions	Introduction, thermodynamic systems, properties & state, process & cycle, force, energy, pressure, specific volume, zeroth law.	2
3-4	Properties of pure	Phase equilibrium, independent properties, and	3.1-3.3,3.6,

	substances	equations of state, compressibility factor.	3.7
5-6	Properties of pure substances	Tables of thermodynamic properties & their use. Thermodynamic surfaces	3.4, 3.5
7	Work and heat	Definition of work and its identification, work done at the moving boundary	4.1, 4.2, 4.3,4.5
8	Work and heat	Concept of heat, comparison of heat and work, Engineering Applications	4.6, 4.8, 4.9
9-10	First law for control mass	First law for a cycle as well as for a change of state; internal energy & enthalpy	5.1-5.5
11-12	First law for control mass	Specific heats; internal energy, enthalpy & specific heat of ideal gases; first law as a rate equation; problem analysis & solution technique, Engineering Applications	5.6-5.8, 5.10
13-15	First law for control volume	Conservation of mass in control volume; first law for control volume; SS process; examples of SS processes	6.1-6.4
16	First law for control volume	Transient processes; examples, Engineering Applications	6.4- 6.6
17-21	Second Law of Thermodynamics	Limitations of first law & need for the second law;Reversible process; heat engine, heat pump, refrigerator; Carnot cycle;Two propositions regarding efficiency of Carnot cycle; energy-conversion efficiency and COP, Kelvin-Planck &Clausius statements, Thermodynamic temperature scale, The ideal gas Carnot Cycle, Engineering Applications	7.1 – 7.10
22-24	Entropy	The inequality of Clausius, Concept of entropy; the Need of entropy definition of entropy; entropy of a pure substance;	8.1-8.3
25-28	Entropy	entropy change of a reversible & irreversible processes; principle of increase of entropy, thermodynamic property relation; problem analysis & solution techniques etc.	8.4-8.13
29-30	Second law for control volume	Second law for control volume; SS & Transient processes; SSSF process; principle of increase of entropy	9.1-9.4
31-32	Second law for control volume	Understanding efficiency and related problems; problem analysis & solution technique, Engineering Applications	9.5
33-37	Irreversibility and availability	Available energy, reversible work & irreversibility for control mass and control volume processes; second law efficiency, Exergy balance equation, Engg Applications	10.1 – 10.4
38	Thermodynamic relations	Clapeyron equation, Maxwell relations, Thermodynamic relation for enthalpy, internal energy, and entropy, expansively and compressibility factor, equation of state, generalized chart for enthalpy and entropy change, developing tables of property from experimental data	14.1 – 14.5, 14.7-14.9

Evaluation Scheme

Evaluation Component	Duration	Marks	Date and Time	Nature of Component
Mid Semester	90 min	90	6/3 11:00 - 12:30 PM	OB
Tutorials Test (8)	15 min/each	90	Surprise in nature	
Comprehensive Examination	180 min	120	3/5 AN	CB

Note: Booklet on "Thermodynamic Tables, Figures & Charts", as prescribed, will be allowed in the closed book tests also. However, **it should not be defaced by writing any formula, equations, etc.**

Chamber consultation hours: To be announced by the respective instructors.

Notices: All notices concerning the course will be displayed on the **FD-II notice board and Nalanda**.

Make-up: No make-up will be given for tutorial tests and quiz; Make-up request for the mid-semesteris to be forwarded through the respective tutorial section instructor only.

Dr. Sachin U.Belgamwar
Instructor–in-Charge
BITS F111

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
INSTRUCTION DIVISION
Course Handout (II-SEM, 2017-18)

Course Number : CHEM F111
Course Title : General Chemistry
Instructor-in-charge : **Shamik Chakraborty**
Instructors :Ajay K. SahAnil Kumar, Bibhas RSarkar, Inamur R Laskar, Indresh Kumar, Madhushree Sarkar, Paritosh Shukla, Rajeev Sakhuja, Saumi Ray, Shamik Chakraborty, Subit Kumar Saha, and Surojit Pande.

Objectives:

The course is composed of two parts. The first part provides a comprehensive survey of various topics in electronic structure of atoms and molecules, spectroscopy, bonding, Coordination Chemistry and second part focuses on understanding of the structure and properties of organic compounds and NMR.

Text Books:

T1: P.W. Atkins and Julio de Paula, Elements of Physical Chemistry: 6th Edition, Oxford University Press, Oxford, reprinted in 2015.

T2: T. W. Graham Solomons, Craig B. Fryhle,and Scott A. Snyder,Organic Chemistry, 12th Edition, John Wiley & Sons, Inc. New York, 2017

Reference Books:

R1: J. D. Lee, Concise Inorganic Chemistry, 5th Edition, Blackwell Science, Oxford, 1999.

R2: Physical Chemistry, David Ball

R3: Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edition, Huheey, Keiter

R4: R. T. Morrison and R. Boyd, 'Organic Chemistry', 6th Edition, PHI, New Delhi, 1992.

Course Plan:

LN	Topic	Learning Objectives	Text[a]	Learning Outcome
1-3	Quantum Theory: Origins	Origin of quantum mechanics, photoelectric effect, black body radiation, wave function, Schrodinger equation, Uncertainty principle, few postulates of quantum mechanics	T1: 12.1-12.6	• Recognize the need for quantum theory • Consolidate new concepts to be used in quantum mechanics
4-5	Quantum Theory: Applications	Particle in a box, bound state, zero-point energy, harmonic oscillator, molecular vibrations, dissociation energy, anharmonicity, angular momentum and rigid rotor	T1: 12.7-12.9	• Clarification on quantization of states, zero-point energy in simple systems.
6-8	Quantum Chemistry: Hydrogenic atom	Energy levels and wave functions, orbitals, Spectral transitions,	T1: 13.1-13.7	• Translate the concepts of quantum mechanics in real molecular systems.
9-10	Quantum Chemistry: Many-electron atoms	Pauli principle, many electron wavefunction, Orbital approximation, aufbau principle, term symbols, spin-orbit coupling.	T1: 13.8-13.12, 13.17-13.19	• Identify spin as another coordinate. • Interpret atomic transitions in terms of electronic states.
11-12	Chemical Bonding	Valence bond theory; MO theory: LCAO, bonding and antibonding orbitals	T1: 14.1-14.10	• Chemical bond: a need between atoms • Distribution of electron in MO, bond order calculation

13-16	Spectroscopy: Rotational and Vibrational Spectroscopy; Raman Spectroscopy, Electronic transitions	Absorption and Emission, different regions of electromagnetic spectrum, molecular rotation, molecular vibrations, normal modes, and rotational transitions accompany vibrational transitions, Boltzmann population distribution. Electronic spectroscopy, Lambert Beer's law	T1: 19.1-19.6, 19.7-19.13 20.1-20.8	• Use the concept of quantum mechanics to understand the molecular spectroscopy • Concept of bond stretching, vibration of molecule • Identify spectroscopy as an important tool in modern science
17-20	Spectroscopy: Nuclear Magnetic Resonance	Principles, chemical Shift, fine structure, ^{1}H and ^{13}CNMR of simple compounds	T1: 21.1-21.6 T2: 9.1-9.11C (for examples)	Theoretical aspect of ^{1}H-NMR, Chemical shift and determination of organic molecular structure through ^{1}H, ^{13}C-NMR
21-23	Coordination Chemistry: Coordination compounds	Double salts and coordination compounds. Werner's work; effective atomic no. concept.; Chelates and isomerism; shapes of d orbitals, crystal field theory, octahedral complexes, spectrochemical series	R1: p194-200 (SS); p202-214; p222-224, p232-235	• The concept of chelates and coordination compounds • Development of coordination complexes in light of various theories
24-26	Distortion of Complexes; Tetrahedral, Octahedral, and Square planar arrangement	Jahn-Teller distortion: Effect of geometrical distortions on stability, stability in other geometries	R1: p214-222	• Nature of ligand, idea of different orbitals and their effect in inorganic complexes • Idea of distortion in tetrahedral, octahedral, and square planar complexes
27-29	Coordination Chemistry: Octahedral complex, CFSE, and Electronic spectroscopy of Oh complexes	CFSE, effects of crystal field splitting, Electronic spectra of octahedral complexes, Applications of term symbols, Thermodynamic and kinetic aspects of Inorganic complexes, Latimar and Frost diagram	R1: p210-214, p219-222 R1: p947-960 R3: p262-264, 380-381, 385-389	• Spectral nature of inorganic complexes • Effect of strength and the symmetry of ligand field on various energy levels • Identify the nature of stable and unstable complexes
30-31	Conformations	Rotation around sigma bonds, conformational analysis of butane, cyclohexane, and di-substituted cyclohexanes	T2: 4.8-4.9, 4.10 (SS), 4.11-4.12, 4.13	• Conformation and configuration of acyclic and cyclic *i.e.* substituted cyclohexane
32-34	Stereochemistry	Isomerism, chirality, origin of optical activity, stereochemistry of cyclic & acyclic saturated and unsaturated, resolution.	T2: 5.1-5.14, 5.15-5.18, 7.2	• Concept of chirality and optical activity, learn to stereochemistry for compound having chiral carbon and resolution of enantiomers
35-37	Aromaticity & Pericyclic reactions	Huckel rule, aromatic compounds, electrocyclic and cycloaddition	T2: 14.7-14.8B; 15.1-	• Concept of aromaticity and related rules. Different

		reactions	15.11	pericyclic reactions including cycloaddition
38-41	Reaction Mechanisms	Nucleophilic (S_N1, S_N2, S_NAr etc.) and electrophilic substitution reactions; electrophilic addition reactions; Elimination reactions (E1, E2 and Hoffmann and Cope elimination)	T2: 6.2-6.13; 7.5-7.9, 20.12 T2: 8.1 (SS), 8.2-8.9, 8.12-8.15, 10.9	• Nucleophilic and electrophilic substitution reactions • Different addition and elimination reactions

[a]Please refer the lecture slides for determining the depth of the content covered under each topic.

Evaluation scheme:

Component	Duration	Weightage (%)	Date and Time	Remarks
Mid Semester test	90 min	30	10/3 4:00- 5:30 PM	Closed book
Continuous Evaluation[‡]	15 min	25	Continuous	(i) Assignment (Closed book) (ii) Quiz (Closed book)
Compre Exam.[$]	3 hours	45	14/5 AN	(i) 20% (Closed Book, MCQ) (ii) 25% (Open Book descriptive)

[‡]Tutorial hour will be used for a quick review of the highlights of the material covered in the lectures, clarification of doubts and problem solving. Overall **six** continuous evaluation component (15 Marks each) will be conducted throughout the semester. **Best Five** of the overall continuous evaluation components will be considered for final evaluation. Continuous evolution components would be two types, viz., Assignment and Quiz. Assignment (close book): a set of problems will be assigned periodically, of which the instructor will specify one to be solved by the students either in the tutorial hour or in a specified time beyond the class hours.Quiz (Close Book): a short quiz based on the lectures covered recently. Only scientific non-programmable calculators are allowed during the tutorial, mid-semester and comprehensive examinations.

[$]Comprehensive examination will have a close book quiz portion and an open-book section. **Only text-books, reference books, class/tutorial notes, and course material (if any provided) will be allowed in the open book examination.**

Chamber consultation hours: To be announced

Notices: Notices, if any, will be displayed on the **Nalanda&Department of Chemistry Notice Board only.**

Make up: Make up would be considered only for **genuine reasons.**Make-up for continuous evaluation (assignments/quizzes) will be considered (for genuine cases) only if more than one assignments/quizzes is missed by a student.

Instructor in-Charge
CHEM F111

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
PILANI CAMPUS
Instruction Division

Second Semester 2017-2018

Course Handout (Part II)

January 28, 2017

In addition to part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No.	: CS F111
Course Title	: COMPUTER PROGRAMMING
Instructor-in-charge	: Dr. Manoj Kannan
Lecture Instructors	: Dr. Sundaresan Raman (sundaresan.raman@pilani.bits-pilani.ac.in)
	Dr. Manoj Kannan (manojkannan@pilani.bits-pilani.ac.in)
Lab Instructors	: Dr. Sundaresan Raman (sundaresan.raman@pilani.bits-pilani.ac.in)
	Dr. Lavika Goel (lavika.goel@pilani.bits-pilani.ac.in)
	Dr. Mayuri Digalwar (mayuri@pilani.bits-pilani.ac.in)
	Ms. Aryav Yadav (p20170026@pilani.bits-pilani.ac.in)
	Ms. Prerna Kaushik (p2013192@pilani.bits-pilani.ac.in)
	Mr. Harry Johnson (h20170120@pilani.bits-pilani.ac.in)
	Mr. G. Sasidhar (h20170122@pilani.bits-pilani.ac.in)

1. Course Description:

The primary goals of the course are to introduce:

- Basic representation of data and how to process data using the representation inside a computer.
- Techniques for specifying data, operations on data, and problem solving using C programming language.
- Systematic techniques and approaches for constructing programs.

2. Scope of the Course:

The course covers the following topics: Basic Model of a Computer; Problem Solving – Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files.

3. Learning Outcomes:

- Given the requirements for any computational problem, or given an algorithm, the students will be able to write equivalent program in high-level language such as C.
- Given a problem that's iterative in nature, students would be able to use the loop constructs appropriately, using nested loops if required.
- Given the memory requirements, students will be able to design the appropriate data structures (static, dynamic memory allocation) for the given problem.
- Given a complex problem, students will be able to logically break down into simpler functions and implement them in C.
- Given any type of data, students will be able to predict their internal representation and thus reason particular outputs for a given input.
- Given the requirements, students will be able to write programs to create files, update files and read data from files.

4. Textbook:

T1: Hanly, J.R. and E.B. Koffman. *Problem Solving and Program Design in C (7/e)*. Pearson Education, 2013.

5. Reference Books:

R1: Patt, Yale. Introduction to Computing Systems: From bits & gates to C & beyond (2/e). McGraw Hill Education, 2017.

The authors take a bottom-up approach to introduce computers and computing.

R2: Forouzan, B.A. and Richard F. Gilberg . Computer science A structured programming approach using C (3/e). Cengage Learning, 2007.

The book gives a fairly comprehensive overview of C, with several example programs.

R3: Gottfried, B.S. and Jitender Chhabra. Programming with C (Schaum's Outlines Series, 3/e). McGraw Hill Education, 2017.

Another beginner's book on C programming, with lots of drill exercises and programs.

R4: Kernighan, B.W and Dennis Ritchie. The C Programming Language (2/e). Pearson Education India, 2015.

Considered the ultimate treatise on C, it conveys the philosophy and practice of C very tersely, but is pitched at an advanced beginnger level.

R5: Das, S. Unix: Concepts and Applications (4/e). McGraw Hill Education, 2017.

Provides a great introduction to using Unix commands.

6. Lecture Plan:

Lec. #	Learning Objectives	Topics to be covered	Learning Outcomes	Reference to Text
01	Introduction to the course	Introduction to Programming; need for programming; overview of computers and computing; learning outcomes	Students can write simple C programs, compile and execute them in a Unix environment	T1: 1.1-1.3
02-03	Introduction to working with Unix (Linux)	Compilation and execution of a program, other useful Unix commands		R5
04-06	Representation of numbers inside the computer	Internal representation of data; IEEE floating point representation of numbers		R1
07	Solving problems using flowcharts	How to express a problem using flowcharts, using prime number problem as an example		T1: 2.4; Class notes
08-09	Overview of the C programming language	A programming example – prime numbers		Notes
10-11	Simple data storage and manipulation	Data Types; variable names; sizes, constants and declarations	Students can evaluate a complex arithmetic expression; also specify the exact internal data representation.	T1: 2.1-2.2

Lec. #	Learning Objectives	Topics to be covered	Learning Outcomes	Reference to Text
12-14	Flow of control	Statements – if... else, if... else... if, switch Loops – while; do... while; for; break and continue	Given a problem that's iterative or conditional in nature, students would be able to use the loop constructs / if-else construct appropriately.	T1: 4.1-4.3, 4.7-4.8, 5.1-5.2, 5.4-5.8
15-19	Modularity and program structure	Functions and program Structure; return types; scope rules; header files Recursion The C Preprocessor	Given a complex problem statement, students will be able to logically break down into simpler modules involving pointers and arrays, and write a modular program using functions.	T1: 3.1, 3.4-3.5, 6.1-6.4, 10.1-10.4
20-24	Pointers and Arrays	Pointers and function arguments; call by value; call by reference; pointer arithmetic; arrays of pointers; string manipulation		T1: 6.1, 8.1-8.5, 9.1-9.5
25-28	Multi-dimensional arrays	Multidimensional arrays; pointers vs. multidimensional Arrays; Command Line Arguments		T1: 8.7-8.8, 13.7
29-33	User-defined data types	Structures and unions; enumerated data types; type definitions	Students will be able to create user-defined data types pertaining to a given problem, create and manipulate data structures using dynamic memory management, and handle text files.	T1: 14.3-14.4
34	Input and Output	Standard input and output functions; formatted input and output; File handling		T1: 2.3

Lec. #	Learning Objectives	Topics to be covered	Learning Outcomes	Reference to Text
35-40	Dynamic memory and simple data structures in C	Dynamic memory management; linked lists		T1: 12.1-12.2 Notes

7. Evaluation Scheme:

#	Evaluation Component	Marks	Date and Time	Remarks
1	Mid-semester Test	35 (17.5%)	09-Mar-2018 4:00 – 5:30 PM	Closed-book
2	Comprehensive Examination	75 (37.5%)	11-May-2018 3:00 – 6:00 PM	One section will be open-book
3	Online Programming Test	25 (12.5%)	22-Apr-2018	Open-book; 1½ hours
4	Quizzes/Assignments	35 (17.5%)	To be announced	Some may be given online
5	Practical session evaluation	30 (15%)	During the weekly practical session	Each practical session will be evaluated out of 3 marks

8. Practical Sessions:

Supervised practical sessions will be held every week wherein the students will practice writing, executing and debugging C programs in a Unix environment. Students are expected to work in their respective Linux accounts created on the *Prithvi* server (172.24.16.31). Every student is expected to maintain a laboratory record notebook in which the programs are documented and brought to the lab every week. Each lab session will be evaluated for 3 marks – 1 mark for attendance and punctuality, 1 mark for active participation, and 1 mark for lab record completion.

9. Attendance Policy:

Attendance shall be recorded in lectures and practical classes. Poor attendance is likely to:

- Have your user privileges on Prithvi server suspended;
- Have you lose an opportunity to take part in assignments and quizzes;
- Make you miss out on great classroom experience.

10. Makeup Policy:

For a foreseen absence, make-up request should be made personally by meeting the Instructor-in-Charge. Reasons for unanticipated absence that qualify one for make-up include medical or similar personal emergencies only. In such cases, the Instructor-in-Charge must be informed either by email or by telephone. Usually, make-ups for regular laboratory sessions and assessments held therein are not awarded. The decision by the Instructor-in-Charge regarding granting makeups shall be final.

11. Grading Policy:

Award of grades would be guided in general by the histogram of marks. Decision for borderline cases would be based on the student's attendance in lectures and laboratory sessions, and instructors' overall assessment of the individual's sincerity and endeavour. If a student does not give sufficient opportunity for being assessed, either by missing a component entirely or by not applying oneself to the task seriously, he/she may be awarded 'NC' report.

12. Chamber Consultation Hour:

Dr. Manoj Kannan – Fridays 4:30 to 5:30 PM in Rm. 3270; Phone: 01596–515855

Dr. Sundaresan Raman – (To be announced) in Rm. 6121-O; Phone: 01596–515684

To contact the practical class instructors for consultation, you may send them an email.

13. Announcements and Notices:

All announcements will be done in the classroom, and may be followed up with an email. For sharing course material, either *Nalanda* (nalanda.bits-pilani.ac.in) or Google Drive may be used. Important notices, such as seating arrangement for tests and exams, will also be displayed on notice boards.

Instructor-in-Charge
CS F111

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus

INSTRUCTION DIVISION
SECOND SEMESTER 2017-2018
Course Handout (Part-II)

Date: 06/01/2018

In addition to Part-I (General Handout for all Courses appended to the time table) this portion gives further specific details regarding the Course.

Course No.	**: MATH F112**
Course Title	**: MATHEMATICS-II**
Instructor-incharge	**: TRILOK MATHUR**
Instructors	**:** Amit Kumar, Amol Holkundkar, Ashish Tiwari, Balram Dubey, Bhavya Tripathi, Bhupendra Kumar Sharma, Biswanath Layek, Devendra Kumar, Jitender Kumar, K. Satya Pritam, Krishnendra Shekhawat, Parvin Kumari, Rajesh Kumar, Sanjay Lamba, Sangita Yadav, Shivi Agarwal, Srijata Dey, Srikanth.

1. Scope and Objective of the Course: The course is meant as an introduction to Linear Algebra and Theory of Functions of Complex Variable and their applications.

2. Course Description: System of linear equations, Eigenvalues and eigenvectors, Vector spaces, Basis and dimension of vector spaces, Linear transformations, Range and kernel, Orthogonality. Function of complex variables and their analyticity, Elementary functions, Integration, Taylor and Laurent series expansions, Calculus of residues and its applications.

3. Text Books:

(i) Elementary Linear Algebra by S. Andrilli and D. Hecker, 4th Edition, 2012, Elsevier.
(ii) Complex Variables and Applications by R.V. Churchill and J.W. Brown, 8th Edition, 2014, McGraw-Hill.

4. Reference Books:

(i) Linear Algebra: A First Course with Applications by Larry E. Knop, 1st Edition, 2008, Chapman & Hall.
(ii) A Modern Introduction to Linear Algebra by Henry Ricardo, 1st Edition, 2009, Chapman & Hall.
(iii) Introductory Linear Algebra: An Applied First Course by Bernard Kolman and David R. Hill, 9th Edition, 2014, Prentice Hall.
(iv) A First Course in Complex Analysis with Applications by Dennis G. Zill & Patrick Shanahan, 2nd Edition, 2009, Jones & Bartlett.
(v) Complex Variables with Applications by A. D. Wunsch, 3rd Edition, 2004, Pearson Education.
(vi) Complex Analysis by Lars Ahlfors, 3rd Edition, 1979, McGraw-Hill.

5. Course Plan:

Lec. No.	Learning Objectives	Topics to be covered	Sec. No.
A. LINEAR ALGEBRA (Text Book (i))			
1-3	Solving system of linear equations.	Solutions of linear systems of equations by Gauss Elimination, Gauss-Jordan method. RREF, Rank, Inverse of matrices.	2.1- 2.4
4-11	Introduction to abstract vector spaces, finite and infinite dimensional vector spaces and related concepts.	Vector spaces, subspaces, linear independence, basis and dimension.	4.1-4.6
12-18	Introduction to linear transformations, examples of linear transformations, understanding the link between linear transformations and matrices.	Coordinates and change of basis. Linear transformations, kernel and range of linear transformation. The matrix of a linear transformation, Composite and invertible linear transformations.	4.7, 5.1-5.5
19-20	Computing eigenvalues and eigenvectors.	Eigenvalues and eigenvectors.	3.4
B. COMPLEX VARIABLES (Text Book (ii))			
21-22	Quick revision of complex numbers and their properties.	Review	1-11
23	Evaluation of limits in complex plane. Testing continuity of complex valued functions.	Functions of a complex variable. Limit and continuity	12,15-18
24-26	Introduction to analytic functions. Singular points of a complex valued function.	Derivative, CR-equations, analytic functions.	19-26
27-30	Study of elementary functions. These functions occur frequently all through the complex variable theory. Understanding multiple valued function, branch cut and branch point	Exponential, trigonometric and hyperbolic functions. Logarithmic functions, complex exponents, inverse functions.	29-36
31-32	Integrating along a curve in complex plane.	Contour integrals, anti-derivatives.	37-44
33-34	Techniques to find integrals of different functions over particular contours.	Cauchy--Goursat Theorem, Cauchy Integral Formula, Morera's Theorem.	46,48-52
35	Application of complex variable theory in Abstract Algebra.	Liouville's Theorem, Fundamental Theorem of Algebra.	53
36	Series expansion of a function analytic in an annular domain. To	Laurent series.	60,62

	study different types of singular points.		
37-38	Calculating residues at isolated singular points.	Residues, Residue Theorem.	68-76
39-40	Application of complex integration to evaluate improper real integral.	Improper real integrals.	78-81,85

6. Evaluation Scheme:

EC No.	Evaluation Component	Duration	Weightage (%)	Date	Nature of Component
1.	Mid Semester Exam	90 min.	35	5/3 11:00 - 12:30 PM	Closed Book
2.	Class Performance Tests (Quizzes)	15 min. each	20	Unannounced	Closed Book
3.	Comprehensive Exam	180 min.	45	1/5 AN	Closed Book/ Open Book

7. Assignments: Two assignments will be given to the students, first one from Linear Algebra and second one from Complex Variables. One question from each assignment may be asked in Mid Semester and/or Comprehensive Exams.

8. Notices: All notices about the course will be put on Department of Mathematics Notice Board and on Online Notice Board (NALANDA).

9. Chamber Consultation Hour: To be announced in the class by the respective Instructors.

10. Make UP Policy:

(i) **NO MAKE UP** will be given in *Class Performance Tests* **under any circumstances**.

(ii) Make up of other evaluation components (Mid Sem. and Comprehensive Exam) will be granted only in **genuine cases**. **Permission must be taken in advance** except in extreme cases.

(iii) **No MAKE-MAKE-UP will be entertained**.

(iv) Students must write their class performance tests / assignments in their own tutorial sections **ONLY**. If a student would write any of class performance tests / assignments in a section, different from his own tutorial section, then it would **not** be evaluated.

Instructor-In-Charge
MATH F112

SECOND SEMESTER 2017-2018
COURSE HANDOUT (Part II)

In addition to Part I (General Handout for all courses appended to the time table) portion here give specific details regarding the course.

Course Number	**:**	**MATH F113**
Course Title	**:**	**Probability & Statistics**
Instructor-In-Charge	**:**	**PRADIPKUMAR H. KESKAR**
Instructors	**:**	**C. B. Gupta, Chandra Shekhar, Jitender Kumar, Krishnendra Shekhawat, Priyanka Kumari, Rajesh Kumar, Rajiv Kumar, Santosh Kumar Yadav, Satyendra Singh, Shivi Agarwal, Shruti, Sumanta Pasari, Suresh Kumar, Swati Sharma**

1. Scope and objective of the course:

Probability theory deals with many real life problems, which either inherently involve the chance phenomena or describe the behavior of the system explicitly with statistical properties. Interpretation of the system behavior in many engineering aspects depends on concept of probability and statistics that familiarize with the computational aspects. The course deals with basic properties of various distributions and other related things.

2. Text Books:

1. Milton, J. S. and Arnold, J. C.: Introduction to Probability and Statistics Principles and Applications for Engineering and the Computing Sciences, 4th edition, Tata McGraw-Hill, 2007.

3. Reference Books:

1. Meyer, P. L.: Introduction to Probability & Statistics, 2nd edition, Oxford & IBH, 1970.
2. Ross, Sheldon M.: Introduction to Probability Models, 3rd edition, Elsevier, 2009.
3. Walpole, R. E., Myers, R. H., Myers, S. L., Ye, K.: Probability & Statistics for Engineers and Scientists, 8th edition, Pearson Education, 2007.
4. Johnson, R. A.: Miller Freund's Probability and Statistics, 7th edition, PHI, 2005.

4. Lecture Plan:

Module	Lecture session	*Sections*	Learning Outcome
1. Various Concepts in Probability Theory	**L 1** Introduction to probability, sample spaces, events, permutations and combinations **L 2-4** Axioms of probability, conditional probability, independence and the multiplication rule, Bayes' theorem	1.1, 1.2, 1.3 2.1, 2.2, 2.3, 2.4	Formulating the foundations for probability vis a vis practical notions
2. Discrete Distributions	**L 5-8** Random variables, discrete probability densities, cumulative distribution, expectation, variance and standard deviation, geometric distribution, moment generating function **L 9-11** Binomial distribution, hypergeometric distribution, Poisson distribution	3.1, 3.2, 3.3, 3.4 3.5, 3.7, 3.8	Understanding basic theory of discrete distributions and studying important discrete distributions
3. Continuous Distributions	**L 12-15** Continuous densities, cumulative distribution and distribution parameters, uniform distribution, gamma distribution, exponential and chi-squared distribution. **L 16-20** Normal distribution, standard normal distribution, Chebyshev's inequality, normal approximation to binomial distribution	4.1, 4.2, 4.3 4.4, 4.5, 4.6	To understand theory of continuous distributions and study some important continuous distributions
4. Joint Distributions and Simulation	**L 21-24** Joint densities and independence, marginal distribution: discrete and continuous, expectation, conditional densities (discard regression) **L 25-26** Simulation of discrete and continuous random variables	5.1, 5.2, 5.4 3.9, 4.9	Simultaneous behavior of several random variables and simulating a random experiment
5. Descriptive Statistics and Estimation	**L 27-28** Random sampling, sample statistics **L 29-31** Point estimation, method of moments & maximum likelihood, functions of random variables, central limit theorem.	6.1, 6.3 7.1, 7.2, 7.3, 7.4	Concepts of sampling and their applications to estimate population parameters

6. Statistical Inference	**L 32-35** Interval estimation of variability, estimating the mean and Student-t distribution, hypothesis testing, hypothesis tests on the mean **L 36-38** Estimating proportions, hypothesis tests on a proportion	8.1, 8.2, 8.3, 8.4, 8.5 9.1, 9.2	Applications to estimation of intervals and testing of hypotheses on population parameters
7. Simple Linear Regression and Correlation	**L 39-40** Model and parameter estimation, correlation	11.1, 5.3, 11.6	To study nature of relationship between random variables

5. Evaluation Scheme:

EC No.	Evaluation Component	Duration	Weightage (%)	Marks	Date & Time	Remarks
1	Mid-Semester	90 mins	35	105	8/3 11:00 - 12:30 PM	Closed Book
2	Class Tests (quizzes)	15 minutes each	20	60	Unannounced	Closed Book (Best 3 out of 4)
3	Comprehensive	180 mins	45	135	8/5 AN	Closed / Open Book

6. Announcements:

All notices in relation to the above course will be posted on NALANDA and Department of Mathematics notice board.

7. Make-up policy:

Make-up for the mid-semester/comprehensive examination will be given to genuine cases with prior permission only. For Class Tests component, there will be **NO** make-up under **any circumstances**.

8. Chamber consultation hour :

To be announced in the respective tutorial class by the respective instructor.

Instructor-In-Charge
MATH F113

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus

INSTRUCTION DIVISION

SECOND SEMESTER 2017 -2018

Revised Course Handout (Part-II)

Date: 8/01/2018

In addition to part I (General handout for all courses appended to the timetable) this portion gives further details regardingthe course.

Course Number: PHY F111
Course Title: Mechanics Oscillations and Waves
Instructor-in-Charge: Debashis Bandyopadhyay
Team of Instructors: Debashis Bandyopadhyay, Kusum Lata, Niladri Sarkar, Rakesh Choubisa, Rishikesh Vaidya, Srijata Dey, Tapomoy Guha Sarkar and V. Manjula Devi

Scope & Objective: Mechanics Oscillations and Waves is a foundation course in Physics that is mandatory for all the first degree students.

Course Description: The first half of the course deals with the applications of Newton's laws to the systems of particles and the study of linear and rotational motion using polar coordinates and physics of non-inertial reference frames. The second half deals with oscillatory motion, coupled oscillations and waves. There will be three lecture hours and one tutorial hour per week. Whereas the lectures would mostly focus on concepts and illustrative examples tutorial hour will be used to discuss representative problems from the chapters. Tutorial will follow the lectures as closely as possible.

Text Book:

1. An introduction to mechanics, by Kleppner and Kolenkow, Tata McGraw-Hill Indian edition 1999.
2. Vibrations and waves, by A.P. French, CBS Publishers and Distributors, Inc., first Indian edition 1987.

Reference Book:

R1: Physics, Vol.1, by Halliday, Resnick, & Krane, 5th Edition, John Wiley & Sons, Inc., 2002

R2: The Physics of Waves and Oscillations by N K Bajaj, Tata McGraw-Hill 1984.

Course Plan:

Topics from Text Book 1 (T1: Kleppner and Kolenkow)			
Module Number	**Lecture session/Tutorial Session.**	**Reference**	**Learning Outcome**
1. Foundations of Newtonian Mechanics and polar coordinates.	**L1:** Critical overview of Newton's laws **L.2** Introduction to motion in plane polar coordinates **L.3** Illustrative examples on polar coordinates	**T1**Section 1.9in Chapter 1; Chapter 2 and problems related to polar coordinates in chapter 2.	**1.**Critical appreciation of Newton's laws **2.** Given a motion of a body involving circular geometry identify the radial and tangential components of forces and draw a free body diagram. **3.** Solve second order linear differential equation with constant coefficients through simple guess work.
2.Momentum	**L4:** Extended systems and motion of center of mass **L5:** Conservation of momentum its applications and impulse **L6:** Mass varying systems and their applications	**T1** Chapter 3	**1.** Description of an extended system (discrete or continuous) in terms of motion of center of mass. **2.** Formulating momentum conservation (when applicable) with appropriate velocity components referring to inertial systems. **3.** Formulating and solving the equation of motion of a mass varying system.
3. Work and Energy	**L7:** Work energy theorem and concept of potential energy **L8**: Conservative and non-conservative forces. L9: Physics from energy diagrams **L10:** Oscillatory systems and stability analysis	**T1** Chapter 4 (except section 4.14 and problems related to section 4.14)	**1.** Application of work energy theorem for conservative systems. **2.** Calculation of power for non-conservative system **3.** Constructing energy diagrams and extracting physical insights. **4.** Stability analysis and finding frequency of small oscillations.
4. Angular Momentum and Fixed Axis Rotation	**L11:** Angular Momentum and Torque in a fixed axis rotation **L12:** Momentum of inertia and dynamics of pure rotation. **L13:** Dynamics of Rotation and translation **L14:** Conservation of	**T1**Chapter 6	**1.** Finding angular momentum and torque about various choices of fixed axis. **2.** Examining and exploiting conservation of angular momentum to find quantity of interest. **3.** Solving problems involving rotational and

	Angular Momentum **L15:** Angular Oscilllations and stability analysis		translational motion about fixed axis. **4.** Finding frequency of small angular oscillations.
5. Non-inertial frames	**L16:** Galilean transformations, uniformly accelerated frames and pseudo forces **L17:** Principle of equivalence **L18:** Physics of tides **L19:** Physics in rotating coordinate system **L20:** Illustrative problems **L21:** Illustrative problems	**T1** Chapter 8	**1.** Learning to formulate and solve a problem from both inertial and non-inertial reference frames. **2.** Understanding the relevance of non-inertial frames, principle of equivalence and their connection to physics of tides.
Topics from Text Book 2 (T2: A.P. French)			
6. The free vibrations of physical system.	**L22:** Simple harmonic motion (SHM) for different physical systems **L23:** SHM equation **L24:** The decay of free vibrations **L25:** Effect of very large damping	**T2** Chapter 3	**1.** Finding angular frequency of different oscillating systems. **2.** Solving SHM equation using complex exponential. **3.** How the free vibrations get modified by including the dissipative effects. **4.** Calculating the quality and amplitude of damped systems.
7. Forced oscillator and resonance	**L26:** Undamped oscillator with harmonic forcing **L27:** Forced oscillator with damping **L28:** Effect of varying the resistive term **L29:** Power absorbed by a driven oscillator **L30:** Velocity and power resonance	**T2** Chapter 4	**1.**Distinguish between natural and driving frequencies. **2.**Finding the amplitude of a forced oscillator as a function of driving frequency. **3.**Finding average and maximum power input to maintain the oscillations.
8. Coupled Oscillators and normal modes	**L31:** Two coupled pendulums **L32:** Normal coordinates, Normal modes, normal frequencies. **L33:** Illustrative problems **L34:** Forced oscillations of two coupled oscillators **L35:** Many coupled oscillators	**T2** Chapter 5	**1.**Finding equation of motion of coupled free systems. **2.**Calculation of normal mode frequencies. **3.**Finding equation of motion of coupled forced systems **4.**Determining normal modes and their frequencies for N coupled oscillators.

9. Normal modes of continuous systems	**L36:** The free oscillations of stretched strings **L37:** Normal modes of a stretched string, forced oscillations of a stretched string	**T2** Chapter 6	**1.**Calculating linear density of a uniform sting **2.**Finding the permitted frequencies for the free vibrations in strings. **3.**Finding the driving frequency for the amplitude resonance of vibrating string.
10. Progressive waves	**L38:** Progressive waves in one dimension **L39:** Superposition, motion of wave pulses of constant shape **L40:** Phase and group velocity **L41:** Energy and its transportation by a wave	**T2** Chapter 7	**1.**Identifying different types of waves. **2.**Distinguish particle, phase and group velocities in wave motion. **3.**Applying the relationship between phase velocity and group velocity.Finding the energy transported by a wave.

Evaluation Scheme:

EC No.	Evaluation Component (EC)	Duration	Weightage (%)	Marks (300)	Date, Time & Venue	Nature of Component
1	Tutorial Tests	20 mins.	**20**	60	**	Closed Book
2	Midterm Test	90 mins.	**25**	75	7/3 11:00 - 12:30 PM	Open Book
3	Quiz	90 mins.	**20**	60		Closed Book
3	Comp. Exam.	3 hrs.	**35**	105	5/5 AN	Closed Book

** To be announced in tutorial class

*Chamber Consultation Hour***:** To be announced in the tutorial class.

*Notices***:** Notices and solutions will be displayed only on **Nalanda site.** If required sometime on **PHYSICS or FDIII** notice board.

*Make-up Policy***:Very strict**: Make up for tests will be given only to genuine cases. No makeup for tutorials/quiz.

Instructor-in-Charge (PHY F111)

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani

Pilani Campus

First Semester 2018-2019
Instruction Division
Course Handout (Part II)

Date: 02/08/2018

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

Course No. : **MATH F211**
Course Title : **Mathematics-III**
Instructor In-charge : **SANGITA YADAV**
Instructor(s) : **Ashish Tiwari, Balram Dubey, Bhupendra K Sharma, Devendra Kumar, Gaurav Dwivedi, Jitender Kumar, Krishnendra Shekhawat, Navin Singh, Pradeep Kr H Keskar, Rakhee, RR Mishra, Shivi Agarwal, Sumanta Pasari**

1. Course Description

This course reviews and continues the study of differential equations with the objective of introducing classical methods for solving boundary value problems. This course serves as a basis of the applications for differential equations, Fourier series and Laplace transform in various branches of engineering and sciences. This course emphasizes the role of orthogonal polynomials in dealing with Sturm-Liouville problems.

2. Scope and Objectives

- To understand the theory of first and second order ordinary differential equations and learn the methods to solve them.
- To understand the series solution of second order ordinary differential equations and their interval of convergence.
- To understand the Laplace transform, their properties and applications to solve IVPs and BVPs.
- To understand the Fourier series expansion of a function.
- To understand the concept of eigenvalues and eigenfunctions and to use them in solving heat and wave equations.

3. Text Book: Simmons G.F., Differential Equations with Applications and Historical Notes, Tata McGraw Hill, 2nd ed., 1991.

Reference Books:

1. Zill, Differential Equations, Thomson Learning, 5th ed., 2004

2. Shepley L. Ross: Differential Equations, John Willy & Sons, 3rd ed., 1984.

3. Edwards & Penney: Differential Equation and Boundary Value Problems, Pearson Education, 3rd ed., 2009.

4. Course Plan

Module Number	**Lecture session**	**Sections**	**Learning Outcome**
1. To introduce the classical methods to solve first order ordinary differential equations	Revision and self study	1-6	Students will be able to solve first order differential equations of various types.
	L1.1. First order equations	7	
	L1.2. Exact differential equations	8, 9	
	L 1.3. Linear differential equation	10	
	L1.4. Reduction of order	11	
2. To introduce the classical methods to solve second order ordinary differential equations	L2.1-2.2 General solutions of second order ordinary differential equations and some results on linearly dependent (L.D.) and independent (L.I.) solutions	14-15	Students will be able to solve homogeneous second order ordinary differential equations with the knowledge of theoretical details of solutions of differential equations and methods too.
	L2.3. Use of a known solution to determine another L.I. solution of differential equation	16	
	L2.4-2.5. Solving second order homogeneous linear ordinary differential equations	17	
3. To obtain particular solution of nonhomogeneous second order ordinary differential equations.	L3.1 Method of undetermined coefficients	18	Students will be able to obtain a particular solution of nonhomogeneous second order Linear ordinary differential equations.
	L3.2. Method of variation of parameters	19	
	L3.3-3.4. Operator method	23	
4. Properties of solutions	L4.1 Oscillations, Sturm Separation theorem and theorem on infinitely many positive zeros of solution	24	Students will be able to know the behavior of solution of second order ordinary differential equations without solving them.
	L4.2. Sturm comparison theorem	25	

5. To introduce Series solutions method to solve second order Linear differential equation with variable coefficients	L5.1-5.2 .Review of power series and series solution of first order ordinary differential equation, series solutions about ordinary point	26, 27, 28	Students will be able to solve second order Linear differential equations with variable coefficients by using series solution approach.
	L5.3-5.4 Series solutions about regular singular point	29, 30	
	L5.5-5.6 Hypergeometric equations	31	
6. Special functions arising from series solutions of second order Linear ordinary differential equation	L6.1-6.3 Legendre polynomials	44, 45	Students will be able to apply properties of Legendre polynomials and Bessel functions to solve various initial/boundary value problems in their respective engineering and science streams
	L6.4-6.6 Bessel functions	46, 47	
7. Introduction to Laplace Transform, its properties and applications	L7.1 Laplace transform and its existence, inverse Laplace transform	48,49	Students will be able to use properties of Laplace transform in solving initial value problems and boundary value problems.
	L7.2 Applications to differential equations.	50	
	L7.3 Derivatives and integrals of Laplace transforms	51	
	L7.4 Convolution theorem and applications	53	
8. To introduce system of first order ordinary differential equations.	L8.1 Theory on system of equations and introduction to linear system (without proof)	54, 55	Students will be able to solve linear system of first order differential equations with the knowledge of theory of system of first order differential equations.
	L8.2. Homogeneous linear systems with constant coefficients (including Q.5 on page-433 on variation of parameters approach)	56	
9. To introduce Fourier series	L 9.1 Fourier coefficients and problem of convergence	33-34	Students will be able to obtain Fourier series expansion of functions in a given interval, to know its convergence and apply it in
	L9.2 Even and odd functions, cosine and sine series	35	

	L9.3 Extension to arbitrary intervals	36	their respective streams such as getting solution of a vibrating string etc.
10. Boundary value problems.	L10.1 Eigenvalues and eigen functions	40	Students will be able to solve boundary value problems and using orthogonality property of eigenfunctions of Sturm Liouville problems to get eigenfunction expansion of a function.
	L10.2 Sturm Liouville problems	43	
11. To introduce separation of variables method to solve Partial Differential Equations.	L11.1. One dimensional wave equation	40	Students will be able to use separation of variable technique for solving some partial differential equations.
	L11.2 One dimensional heat equation	41	
	Laplace equation (Self study)	42	

***In common hours, practice problems will be done on topics covered in previous lectures.**

6. Evaluation Scheme:

Evaluation Component	**Weightage (Marks)**	**Date & Time**	**Remarks**
Mid-Sem.	35% (105)	12/10 11:00 - 12:30 PM	Closed Book
Comprehensive	45% (135)	8/12 AN	Closed Book/Open Book
Two Quizzes (Announced)	20% (60)	TBA	Closed Book

After completing this course the student will be able to

1) solve differential equations appearing in modeling of various processes in their respective engineering or science stream.
2) understand whether a given initial value problem is solvable or not.
3) understand the region in which the solution is valid (like in series solution approach).
4) solve the problems involving linear system of first order differential equations.
5) understand the eigenfunction expansion/Bessel series expansion of a function using respective orthogonality properties which can be further helpful in solving various problems in their engineering and science streams.

Closed Book Test: No reference material of any kind will be permitted inside the exam hall.

Open Book Exam: Use of textbook and original class notes will be permitted inside the exam hall. Any kind of loose sheets of paper will not be permitted. Computers of any kind will not be allowed inside the exam hall. Use of calculators will not be allowed in any exam. No exchange of any material will be allowed.

Chamber consultation hour: To be announced in the class.

Notices: All notices regarding MATH F211 will be displayed on NALANDA and the notice board of the Department of Mathematics.

Note: It shall be the responsibility of the individual student to be regular in maintaining the self study schedule as given in the course handout, attend lectures and common hours as per the schedule mentioned in time-table. Quizzes, mid Semester test and comprehensive examination are according to the evaluation scheme given in the respective course handout. If the student is unable to appear for the regular test/examination due to genuine exigencies, the student must refer to the procedure for applying for make-up test/examination.

(SANGITA YADAV)
Instructor In charge
MATH F211.

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus

INSTRUCTION DIVISION
FIRST SEMESTER 2018-19
Course Handout (Part II)

Date: 02/08/2018

In addition to Part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. **:ME F211/MF F211**
Course Name **:Mechanics of Solids**
Instructor-in-charge **:SharadShrivastava**
Tutorial Instructor :SharadShrivastava,J.S.Rathore, Rajesh Mishra, Gourav Watts

1. Course Description:

Fundamental principles of mechanics; Introduction to the mechanics of deformable bodies; Forces and Moments transmitted by slender members; Stress- Strain; Stress-Strain Temperature relations; Torsion; stresses and deflections due to bending; Stability of equilibrium; Static failure criteria, ductile and brittle material; Dynamic failure criteria.

2. Scope and Objective:

- Determination of strength, deformation and stability of structural and machine elements.
- Understand the material properties and Idealization of stress-strain curves.
- Understand different loading conditions and to analyse the results.
- Understand combine load conditions on a body and to analyse the results
- Understand the failure theories.

At the end of the course the student will be in a position to design and analyze simple structural elements, which involve calculation of stress, strain and deformation. This is an essential feature in any design process.

3. Text Book:

1. Crandall, Dahl and Lardner, An Introduction to Mechanics of Solids, McGraw-Hill International edition, 1978.

4. Reference Books:

1. Mechanics of Materials, Gere and Timshenko. Latest Edition.
2. Mechanics of Materials; F. P. Beer, E. R. Johnston and J. T. DeWolf, Third Edition, 2002, McGraw-Hill International Edition.

3. Introduction to Solid Mechanics by I. H. Shames, 2nd Edition, 1980, Prentice Hall of India Private Ltd. New Delhi.
4. Engineering Mechanics of Solids by E. P. Popov, 2nd Edition, PHI, New Delhi.

5. Course Plan

Module Number	Lecture session/Tutorial Session.	Reference	Learning Outcome
1.Fundamental principles of mechanics	L1.1. Introduction, principles of mechanics, concept of force & moment, equilibrium conditions	TB Chapter 1	Fundamental priniciples of mechanics and to an exposition of the requirements of equilibrium
	L 1.2. concept of two & three force members, free body diagram, friction, trusses	TB Chapter 1	
	T1.1. Practice Problems	TB/RB	
2.Introduction to mechanics of deformable bodies	L2.1. Analysis of deformable bodies, uniaxial loading & deformation	TB Chapter 2	To attack problems of applied mechanics by applying three steps . The analysis of truss for both statically indeterminate and determinate conditions will be understood
	L2.2. Statical Determinate Truss	TB Chapter 2	
	L2.3. Problems on trusses	TB Chapter 2	
	L2.4. hoop stresses in thin cylindrical shells	TB Chapter 2	
	L2.5. Castiglione's Theorem	TB Chapter 2	
	L2.6.Problems	TB Chapter 2	
	T2. Problems on truss strcuture	TB/RB	
3. Forces & moments transmitted by slender members	L3.1. Introduction of forces & moments acting on a section of a member	TB Chapter 3	In this the study of forces and equilibrium requirements will be applied to slender members. The importance of shear force and bemding moment variation along the length of slender members will be understood
	L3.2.Shear force and BM diagram	TB Chapter 3	
	L3.3 Problems	TB Chapter 3	
	L3.4 Distributed loads & resultant of distributed loads, Differential equilibrium approach, Singularity functions	TB Chapter 3	
	L3.5. Differential equilibrium approach, Singularity functions	TB Chapter 3	
	T3. Problems	TB/RB	
4. Stress & Strain	L4.1. Introduction, stress, plane	TB Chapter 4	The investigation

	stress, equilibrium of an element in plane stress,		of three basic principles will be applied to the localized behavior of the materials at a point within a deformable body. Concept of stress and strain and its variation at a point in different planes will be understood.
	L4.2. Mohr circle representation of a plane stress, general state of stress	TB Chapter 4	
	L4.3 Problems	TB Chapter 4	
	L4.4 Analysis of deformations, strain components, relation between strain & displacement	TB Chapter 4	
	L4.5. Strain component associated with arbitrary set of axis, Mohr circle representation of plane strain, general state of strain	TB Chapter 4	
	L4.6.Problems	TB Chapter 4	
	T4 Problems	TB/RB	
5. Stress-Strain-Temperature relations	L5.1. Introduction, tensile test, idealization of stress strain curve,	TB Chapter 5	The relation between stress and strain will be studied. Also their relation with temperature will be analysed. Different material properties and yielding criterian for ductile materials will be understood.
	L5.2. elastic stress strain relation, Thermal strain,	TB Chapter 5	
	L5.3. complete equations of elasticity, strain energy in a elastic body	TB Chapter 5	
	L5.4. criteria of initial yielding	TB Chapter 5	
	L5.5 Problems	TB Chapter 5	
	T5.Problems	TB/RB	
6. Torsion	L6.1. Introduction, geometry of deformation of a twisted circular shaft, stress strain relations, ,	TB Chapter 6	In this chapter student will apply the fundamental principles to consider the problem of twisting. The stress developed due to torsion will be analysed and corresponding deformation will also be understood.
	L6.2 equilibrium requirements, stresses & deformations in twisted elastic circular shaft	TB Chapter 6	
	L6.3. torsion of elastic hollow circular shaft,	TB Chapter 6	
	L6.4, combined stresses, strain energy due to torsion, yielding in torsion	TB Chapter 6	
	L6.5.Problems	TB Chapter 6	
	T6. Problems	TB/RB	
7.Stresses due to bending	L7.1.Introduction, deformation in	TB Chapter 7	Here the slender

	pure bending, stress-strain relations, equilibrium requirements,		member subjected to transverse loading would be analysed. The stresses and deformation would be analysed .
	L7.2 stresses & deformations in pure bending.	TB Chapter 7	
	L7.3. Stresses due to shear force and bending moment,	TB Chapter 7	
	L7.4. combined stresses, strain energy due to bending, yielding in bending	TB Chapter 7	
	L7.5.Problems	TB Chapter 7	
	T7.Problems	TB/RB	
8. Deflections due to bending	L8.1.Introduction, moment-curvature-relations, integration of moment-curvature relations, Numerical problems	TB Chapter 8	The deflection of slender members which transmit bending moments would be analysed, which would be helpful while designing hifh speed machinery with close tolerances, leaf springs etc.
	L8.2. superposition, Load-deflection	TB Chapter 8	
	L8.3 differential equation, Energy Methods, Problems	TB Chapter 8	
	T8.Problems	TB/RB	
9. Stability of equilibrium buckling	L9.1 Introduction, elastic stability, examples of instability,	TB Chapter 9	In this chapter student will analyse the body when it is deviated from equilibrium conditions.The analysis of columns would be done to predict the stability of structure.
	L9.2 elastic stability of flexible columns	TB Chapter 9	
	L9.3Problems	TB Chapter 9	

6. Evaluation Scheme:

EC	Evaluation	Duration	Weightage	Date, Time &Venue	Nature of

No.	Component				Component
1.	Mid sem. Exam.	1.5 Hrs	30% (60)	10/10 2:00 - 3:30 PM	CB
2	Tutorial	--	20%(40)		OB
3	Quiz		10%(20)		CB
3.	Compre. Exam.	3 Hrs	40%(80)	5/12 FN	CB+OB

7. **Tutorial :** Will be announced in the class. There will be total 6 evaluative tutorial. 3 will be conducted before midsem (out of which best 2 will be considered) and 3 will be conducted after midsem(again out of which best 2 will be considered). **There will be no makeup in any circumstances for evaluative tutorials.**
8. There will be 1 quiz exam most probably in the last week of November after the completion of course.**There will be no makeup in any circumstances for Quiz exam**
9. **Chamber Consultation Hour:** Will be announced by instructors individually in the class.
10. **Make up Policy:** Make-up will be granted only to genuine cases. For cases related to illness, proper documentary evidence is essential. Prior permission is necessary if student is out of station on the test date.
11. **Notices:** Notice, if any, concerning the course will be displayed on the Notice Board of Mechanical Engineering Department.

Instructor-in-charge
ME F211/ MF F211

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus

INSTRUCTION DIVISION
FIRST SEMESTER 2017-2018

Course Handout (Part II)

Date: 02/08/2017

In addition to Part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : **ME F212 / MF F212**
Course Name : **Fluid Mechanics**
Instructor-in-charge : **Shyam Sundar Yadav**
Tutorial Instructor : Shyam Sundar Yadav, Amol Marathe, Ashish Sreevastava, Divyanshu Agarwal

1. **Course Description:**

   Mathematical preliminaries, Fluid statics and forces on submerged bodies, Integral relations for control volume, Mass, Momentum and Energy Conservation, Reynolds Transport Theorem, Differential relations for fluid flow, Navier-Stokes Equation, Dimensional analysis and similarity, Inviscid potential flows, Bernoulli's Equation, Viscous flows, Internal flows, External flows, Introduction to Computational Fluid Dynamics

2. **Scope and Objective:**

   - Introduction of fluid mechanics and establish its relevance in mechanical engineering.
   - Derivation of the equations governing mass, momentum and energy transport.
   - Non-dimensionalization of governing equations and identification of dimensionless numbers, Modeling and similarity concepts.
   - Application of the governing equation to solve simple fluid mechanics problems.
   - Analyze laminar and turbulent flows inside pipes & ducts, Flow past immersed bodies, Boundary layer theory
   - Introduction to computational methods for fluid flows.

3. **Text books (T.B.):**

   1. Frank M White, Fluid Mechanics, 8th Edition, Tata McGraw Hill

4. Reference Books (R.T.):

1. Robert W. Fox & Alan T. McDonald; Introduction to Fluid Mechanics; John Wiley Publications; 8th Edition.
2. James. A. Fay, Introduction to Fluid Mechanics, Prentice Hall of India (2007).
3. James R. Welty; Charles E. Wicks and Robert E. Wilson, Fundamentals of Momentum, Heat and Mass transfer; John Wiley Publications, 4th Edition.

5. Course Plan:

Learning Objectives	No of Lecture Hour	Reference Chap./Sec.# (Book)
Mathematical preliminaries: Scalars, Vectors, Tensors, Indicial notation, Dot and Cross products, Gradient, Divergence and Curl, Forces on a surface, Gauss' and Stokes' theorems,	3	Class notes
Fluid Statics: Introduction, Pressure on submerged surfaces, Rigid body motion	3	T.B. Chapter 1 & 2
Fluids in Motion: Lagrangian and Eulerian representation, Reynolds Transport Theorem, Material derivative	2	Class notes
Integral Relations for a Control Volume: Conservation of Mass, Momentum and Energy for a control volume	6	T.B. Chapter 3
Differential Relations for Fluid Flow: Conservation of Mass, Momentum and Energy for a differential fluid element, Newtonian and Non-Newtonian fluids, Navier-Stokes equations and some exact solutions, Boundary conditions	5	T.B. Chapter 4
Dimensional Analysis and Similarity: Buckingham Pi theorem, Non-dimensionalization of Navier-Stokes equations	4	T.B. Chapter 5
Incompressible Inviscid flows: Euler equation, Bernoulli equation, Stream function, Velocity potential, Elementary inviscid flows: uniform, source, sink, vortex, Superposition	4	R.T 1, Chapter 6, Class notes
Internal Flow: Laminar and turbulent flows in pipes and ducts	5	T.B. Chapter 6
External Flow: Flow past Immersed Bodies, Introduction to Boundary layer theory, Drag and Lift	5	T.B. Chapter 7
Computational Fluid Dynamics: Introduction to CFD	2	Class notes

using Open Source codes		

6. Evaluation Scheme:

EC No.	Evaluation Component	Duration	Weightage	Date, Time & Venue	Nature of Component
1.	Mid sem. Exam.	1.5 Hrs	25%	**9/10 2:00 - 3:30 PM**	C.B.
2	Tutorial	---	20%	As per timetable	O.B.
3.	Quiz	---	15%	Will be announced in class	C.B.
4.	Compre. Exam.	3 Hrs	40%	**3/12 FN**	C.B.+O.B.

7. Tutorials: There will be total 6 evaluative tutorials. Three will be conducted before mid. sem. exam (out of which best 2 will be considered) and 3 will be conducted after mid. Sem. (again best 2 will be considered). **There will be no makeup in any circumstances for evaluative tutorials.**

8. Objective quizzes: There will be two objective quizzes: One based on the syllabus before mid sem. exam. and other based on syllabus after mid. sem. **No makeup in any circumstances for these objective quizzes.**

9. Chamber Consultation Hour: Will be announced by instructors individually in the class.

10. Make up Policy: Make-up will be granted only to genuine cases. For cases related to illness, proper documentary evidence is essential. Prior permission is necessary if student is out of station on the test date. **No make-up for tutorial tests and quiz components.**

11. Notices: Notice, if any, concerning the course will be displayed on the Notice Board of Mechanical Engineering Department as well through emails. The students should check their mails regularly.

12. Open Book Exams: No hand written notes will be allowed. Only the prescribed text book will be allowed.

Instructor In-charge
ME F 212/ MF F 212

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani

Pilani Campus

First Semester 2018-2019
Instruction Division
Course Handout (Part II)

Date: 02/08/2018

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

1. Course No. : **ME F213 & MF F213**

2. Course Title : **Materials Science and Engineering**

3. Instructor In-charge : **Sachin U Belgamwar**

Instructor : **Dr. Murali Palla**

4. Course Description

Introduction, Structure of Materials (Metal and Ceramics), Dislocations, heat treatment of steel and strengthening Mechanisms of Metals, Phase diagrams, Iron-carbide phase diagram, Phase transformation in Metals, Mechanical and thermal properties of Metals, Polymers (Structure, processes and properties), powder metallurgy.

5. Scope and Objectives

CO1. Develop familiarity with the different levels of structure (atomic, crystal, microscopic) in engineering materials and deviations from "perfect" structure (structural defects).

CO2. Understand the effects of microstructure on the mechanical properties of materials.

CO3. Understand the basis for microstructure development in materials.

CO4. Understand how materials are processed.

CO5. Selection of Materials for specific application

6. Prescribed Text Book

T1. Callister, William D., Materials Science and Engineering: An Introduction, 8th Edition, ISBN# 978-0-047-0419977, Wiley, 2010 5.

7. Reference Books

R1. William F Smith, Javad Hashmi and Ravi Prakash, Materials Science and Engineering, Fourth Edition, Tata Mcgraw Hill Education Private Limited, New Delhi.

R2. George E. Dieter, Mechanical Metallurgy, SI Metric Edition McGraw Hill Book Company, London.
R3. R A Higgins, Applied Physical Metallurgy, Sixth edition, Viva Low priced students edition, New Delhi.

8. Course Plan

Module Number	Lecture session/Tutorial Session.	Reference	Learning Out come
1. Introduction to Engineering Materials, structure and properties.	L1.1.Introduction of Engineering materials, classification into metals polymers and ceramics and their properties.	T 1.1-1.6. RL.M1LI	Identifying the relationship between the material structure and its influence on Modulus of elasticity, melting point, strength, etc.,. This is useful in selection of materials.
	L 1.2. Atomic structure, crystal structure, micro structure and macro structure of materials.	T 2.1-2.7 RL.M1l2 and M1l3..	
	T1.1. Exercise problems on structure property correlations.	T 1 and 2	
2. Basic crystalline structure of solids, miller indices for planes, directions, planer density, linear density and properties of solid influenced by crystal structure.	L2.1 Bravice lattice, unit cell, arrangement of atoms in common crystal structure	T 3.1-3.8. RL.M2.1LI	Understanding the relationship between crystal structure and property. Effect of close packed plan and direction on slip system. Deformation behaviors of different crystalline materials.
	L2.2. Miller indices for planes and directions, identification of miller plan and directions. Determination of close packed plan, close packed directions, slip system and influence of crystal structure on properties of materials	T 3.8-3.16 RL.M2l2 and M2L3	
	T2. Exercise problems on crystal structure and its influence on properties.	T 3	
3. Crystal imperfections such as Point, line, planer and volume defects. Influence of crystal defects on properties of materials.	L3.1 Classification of crystal defects, point defects, vacancies, interstitials, vacancy concentration and influence of point defect on properties of materials.	T 4.1-4.6. RL.M3.1LI	Diffusion process, grain boundary strengthening, ASTM grain size number. Effect of dislocation on formability.
	L3.2. Line defects-edge dislocation, screw dislocation, Burger vector. Influence of line defects on plastic deformation of materials and deformation by slip and Planer defects- tilt boundaries, twin boundaries, grain boundaries and surfaces. Influence of planer defect, strengthening mechanisms twinning,	T 4.6-4.11 RL.M3L2 and M3L3	
	T3. Exercise problems on crystal imperfections and its effect.	T 4	
4. Binary phase diagrams, isomorphous and eutectic systems. Cooling curves of pure	L4.1 Cooling curve of pure metal and alloys, method of arriving at phase diagram from cooling curves, Gibb's	T 9.1-9.5 RL.M4.1LI	Understanding the effect of phase diagram on microstructure and

metals, alloys, formation of phase diagram, Gibb's phase rule, lever rule and applications	phase rule and phase equilibrium.		properties of materials and importance of alloy systems.
	L4.2. Isomorphous system of phase diagram with Cu-Ni system as example, liquidus, solidus line, lever rule and determination of phases. Eutectic system with Pb-Sn system as example, eutectic, hypo eutectic, hyper eutectic phase transformations, microstructure and properties	T 9.5-9.11 RL.M4L2 and M4L3	
	T4. Exercise problems on phase diagrams.	T 9	
5. Iron and Iron carbide Phase diagram- solidification of pure iron, allotropy, invariant reactions, steel and cast iron region. Different phases of iron-carbon system and their influence on properties.	L5.1.Cooling curve of pure iron, allotropic transformations, effect of carbon. Three invariant reactions and regions	T 9.17 RL.M5.1LI	Microstructure of steel and cast iron. Influence of carbon on property of steel. Plain carbon steel and alloy steel and properties. Cast iron and it's applications.
	L5.2.Steel region of Fe-Fe_3C phase diagram, eutectoid reaction, phase transformation. Effect of Carbon on properties of steel, Plain carbon and alloy steels, their influence on microstructure and properties.	T 9.18 RL.M5L2	
	L 5.3 Cast iron region of Fe-Fe_3C phase diagram, white cast iron and it's properties, Grey, ductile and Malleable cast iron and their applications	T11.1-11.4 RL.M5L3	
	T5. Exercise problems on Iron- carbon system	T9 and T11	
6.Isothermal transformation, formation of TTT diagram, cooling rate and phase transformation, critical cooling rate, effect of alloying elements. Heat treatment of steel-Annealing, normalizing, hardening, tempering, austempering, martempering, size effect. Effect of heat treatment on microstructure and properties of steel.	L6.1. Brief introduction to solidification of pure metals, critical nucleation sites and growth, transformation rate and temperature. Analogy between liquid to solid transformation and solid to solid transformation, S curves and formation of isothermal transformation diagram, Metallic glasses.	T 10.1-10.5 RL.M6.1LI	Equilibrium and non equilibrium cooling of plain carbon steel and alloy steel and its influence on property of steel. Influence of CCT on casting, welding and other manufacturing processes. Making of tool steels. Cost associated with alloy steel and decision making.
	L6.2. Formation of TTT diagram for eutectoid steel, different phases and regions, influence of cooling rate and phase transformation, critical cooling rate and martensitic transformation.	T 10.6-10.9 RL.M6L2	
	L 6.3 Size effect, hardenability, effect of alloying elements, Austempering and martempering .	T11.8	
	T6. Exercise problems on TTT and CCT diagram.	T 110 and T11	
7. Mechanical properties of	L7.1. Stress-strain diagram of metals,	T 6.1-6.11	Understanding the

materials, tensile testing, fatigue, creep and fracture of materials.	polymers and ceramics. Engineering stress, engineering strain, elastic modulus, True stress, true strain and relations ship.	RL.M7LI	failure of materials and preventing the catastrophic failure, life estimation and residual life assessment. Historic failures and development of fracture mechanics.
	L7.2.Ductile and Brittle fracture, fractography, impact testing, ductile to brittle transition temperature and failure of materials.	T 8.1-8.6 RL.M7L2	
	L 7.3 Fatigue and creep, SN Curve, endurance limit, Types of fatigue cycle and fatigue life estimate..	T8.7-8.11 RLM7L3	
	L 7.4 Creep, typical creep curve, effect of temperature and stress on creep curve, stress rupture test and determination of creep life. LMP approach.	T8.11-T8.15 RLM7L3	
	T9 and T10- Tutorial problems on fatigue, creep and fracture.	T6,T8	
8. Structure of Ceramics, types of crystals, Determination of density. Applications and properties of Ceramics.	L 8.1Determination of coordination number AX,AmXp and AmBnXp structures of Ceramics.	T 12.1-12.3. RLM8.L1	Structure and application of ceramics. Modern ceramic materials and phase diagram.
	L8.2. Density Calculation, silicates and polymorphs of Carbon and their structure.Types and application of ceramics.	T 12.4-12.9 T 13.1-13.7 RLM8L2,3.	
	T 11. Tutorial Problems on Ceramics.	T 12,13.	
9. Structure of polymers, types, application and properties.	L 9.1Determination of coordination number AX,AmXp and AmBnXp structures of Ceramics.	T 14.1-14.7 RLM9.L1	Structure and application of polymers. Modern polymeric materials.
	L9.2 Polymeric structure, crystallinity, polymeric molecules and chemistry, determination of molecular weight. Glass transition temperature, Properties and application of polymers. Advances polymeric materials	T14.8-14.12 RL M9 L2,3	
	T 12. Tutorial Problems on polymeric materials	T 14	
10. Composite materials.	L10.1Types of composite materials, rule of mixtures and it's applications.	T 16.1-16.6 RLM10.L1	Understanding of FRP, MMCs, CMC etc., and selection for different applications and tailor made materials. FGMs and applications.
	L10.2.Control of composite properties, different types and applications, Manufacture and testing of composites	T16.7-16.1 RL10L2-L3	
	T13. Tutorial problems on Composite	T16	

	materials.		
11. Selection of Materials.	L11.1.Materials chart with properties.	T 22.1-22.6 RLM11.L1	Understanding the selection of materials using materials performance index. Life, cost and properties base selection of real time components.
	L11.2Determination of materials performance index and it's use in materials selection decision. Application of materials selection with case study.	T22.6-22.14 RLM11 L2-L3	
	T14. Tutorial problems on selection of Materials.	T22	

9. Evaluation Scheme:

Evaluation components.	Weightage	Day, Date, Session, Time
Quiz	15% (Best 04 out of 06)	will be announced in the class
Online Quiz	15%	OB (will be announced in the class room)
Mid semester examination.	90 Minutes (30%)	14/10 2:00 - 3:30 PM
Comprehensive examinations	180 Minutes (40%)	14/12 FN

After completing this course the students will be able to

1) Select suitable material for the specific application subjected to different constraints in terms of cost, availability, properties, life etc.,.
2) Understand the relationship between the structure and properties of materials.
3) Select suitable heat treatment process of steel to get the desired microstructure and property.
4) Identify the materials from its microstructure.
5) Understand the type of fracture from the fractured surface.

Closed Book Test: No reference material of any kind will be permitted inside the exam hall.

Open Book Exam: Use of any printed / written reference material (books and notebooks) will be permitted inside the exam hall. Loose sheets of paper will not be permitted. Computers of any kind will

not be allowed inside the exam hall. Use of calculators will be allowed in all exams. No exchange of any material will be allowed.

Note:

It shall be the responsibility of the individual student to be regular in maintaining the self study schedule as given in the course handout, attend lectures and the lab demonstration as per the schedule announced in Nalanda. Mid Semester Test and Comprehensive Examination according to the Evaluation Scheme given in the respective Course Handout. If the student is unable to appear for the Regular Test/Examination due to genuine exigencies, the student must refer to the procedure for applying for Make-up Test/Examination. No make up for the tutorials.

(Sachin U Belgamwar)

Instructor In charge

ME F213 & MF F213.

FIRST SEMESTER 2018 – 2019

Date : 2nd August 2018

Course Handout (Part II)

In addition to Part-I (general handout for all courses in the time-table), this handout provides specific details regarding the course.

Course No.:	ME F214 / MF F214
Course Title:	Applied Thermodynamics
Instructor-in-charge:	Dr. Manoj Soni
Instructors:	Vivek Tiwari, Santosh Saraswat, Chetan Jalendra

Scope: The subject matter in this course covers the applications of thermodynamics. This course is designed to acquaint the students with the thermodynamics of power generating and power absorbing machines. The course discusses gas and vapour power cycles, boilers, combined cycle power generation, vapour compression and absorption refrigeration cycles, gas mixtures, psychrometry, and air-conditioning, building cooling/heating load estimation.

Text Books:

1. **Çengel Y.A. and Boles M.A.,** *Thermodynamics*; 8th Ed., 2015; Mcgraw-Hill Education.
2. **NPTEL Notes:** *Refrigeration and Air Conditioning*,

   http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Ref%20and%20Air%20Cond/New_index1.html

Reference Books:

1. **Nag P.K.,** *Basic and Applied Thermodynamics*, McGraw-Hill Education, 2nd Ed., 2009
2. **Nag P.K.,** *Power Plant Engineering*, McGraw-Hill Education, 4th ed., 2014.
3. **Rayner Joel**, *Basic Engineering Thermodynamics*, Person Education.
4. **Arora RC,** *Refrigeration & Air conditioning*, 1st Ed., Prentice Hall India, 2010.
5. **Arora CP**, *Refrigeration and Air Conditioning*; 3rd Ed. 2009; McGraw-Hill Education.

Course Objectives:

- To determine the power output and evaluate the performance of simple thermodynamic cycles for power generation technologies in terms of thermal efficiency.
- To analyze and evaluate the performance of coal based or gas based power generations technologies.
- To analyze and evaluate the performance of vapor compression and vapor absorption refrigeration cycle.
- To analyze and evaluate gas turbine cycle with multistage compression with intercooling, multistage expansion with reheat and regeneration terms of its efficiency.
- To estimate air conditioning requirements of a space using various air-conditioning processes.

Course Plan

Module 1: Vapor Power Cycles

Learning Objectives

- To analyze ideal Rankine cycle for a vapor power plant using T-s plot and evaluate thermal efficiency by applying first law and second law of thermodynamics.
- To evaluate performance of Rankine cycle considering isentropic efficiencies of turbine and pump.
- To represent the Rankine cycle processes on the Mollier diagram (enthalpy-entropy chart).
- To analyze reheat Rankine cycle for a vapor power plant using T-s plot and evaluate its performance by applying first law of thermodynamics.
- To evaluate performance of regenerative Rankine cycle using feed water heaters.
- To study boilers their mountings and accessories.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
1	Simple steam power plant, Internal Combustion Engines, Gas turbine plants, Refrigeration cycle, First and second Law efficiency, COP.	1, TB2
2-10	Carnot cycle deficiencies, Simple vapor power cycle, Ranking Cycle, Actual vapor power cycle, Mean temperature of heat addition. Techniques for efficiency improvement, Reheat and Regenerative cycles with open & closed feed water heaters. Combined cycle power plant and its thermodynamics. Combined Heat and Power.	10, TB2
11-12	Introduction, types of boilers, requirements of a good boiler, High pressure boilers, Fluidized bed Boiler, Boiler mountings and accessories.	Class Notes & RB2

Module 2: Gas Power Cycles

Learning Objectives

- To analyze Gas power cycles for a perfect gas using P-v and T-s plot and evaluate its performance using first law of thermodynamics.
- To evaluate and compare the thermal efficiency of regenerative Stirling/Ericsson cycle with that of Carnot cycle.
- To evaluate effects of multistage compression with intercooling, multistage expansion with reheat and regeneration on performance on a simple gas turbine cycle in terms of its efficiency.
- To analyze combined cycle and binary cycle power plants using first and second law of thermodynamics and evaluate their thermal efficiency.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
13-19	Carnot Cycle, Stirling cycle, Ericsson Cycle, Air Standard Cycles, Otto Cycle, Diesel Cycle, Dual Cycle. Brayton cycle: intercooling, reheating and regeneration. Jet propulsion and Gas Turbine power plants.	9, TB1

Module 3: Refrigeration Cycles

Learning Objectives

- To study simple refrigerators and heat pumps systems and the evaluate of their performance.
- Analyze the ideal and actual vapor compression refrigeration cycle.
- Evaluate the second law efficiency of vapor compression refrigeration cycle.
- Introduce the concepts of vapor absorption-refrigeration systems.
- To determine maximum COP of an ideal absorption refrigeration system.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
20-23	Vapor Compression Refrigeration Cycle, Actual Vapor Compression Cycle, Heat Pump, Second Law Efficiency of Vapor Compression Cycle.	11, TB1
24-26	Basic principle of a Simple Vapour–Absorption System, Comparison of vapour compression refrigeration systems with continuous vapour absorption refrigeration systems, maximum COP of an ideal absorption refrigeration system, properties of ideal and real refrigerant-absorbent mixtures, single stage vapour absorption refrigeration system with solution heat exchanger.	15, TB2; RB3 & RB4

Module 4: Air and Gas Compressors

Learning Objectives

- To classify compressors
- To study reciprocating compressors and the evaluate of their performance.
- To study the effect of clearance volume on performance of reciprocating compressors.
- Analyze multistage reciprocating compressor with intercooling and determine condition of minimum work required.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
27-29	General Introduction, The reciprocating air compressor, Effect of clearance volume, Multistage Reciprocating Compressor	14, RB2

Module 5: Properties of moist air and Psychrometry of air-conditioning systems

Learning Objectives

- Differentiate between dry air and atmospheric air.
- To define and calculate the specific and relative humidity of atmospheric air.
- To Calculate the dew-point temperature of atmospheric air and to relate the adiabatic saturation temperature and wet-bulb temperatures of atmospheric air.
- To determine the properties of atmospheric air using psychrometric chart.
- To apply the principles of the conservation of mass and energy to various air-conditioning processes.
- To estimate heating and cooling loads of a space to be air conditioned.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
30-32	Psychometric Properties, Psychrometric Chart, Mixing of moist air, Psychrometry of air conditioning processes.	13 & 14, TB1; TB2, RB3 & RB4
33-36	Inside and Outside Design Conditions, Simple Summer Air Conditioning System, Supply Air condition and flow rate, Apparatus Dew Point, Winter Air Conditioning. Building Cooling Load and Heating Load Estimate.	13 & 14, TB1; 30, TB2 RB3 & RB4

Module 6: Compressible fluid flow

Learning Objectives

- To develop the general relations for compressible flows encountered when gases flow at high speeds.
- To derive the relationships between the static and stagnation fluid properties as functions of specific-heat ratios and Mach number.
- Derive the effects of area changes for one-dimensional isentropic subsonic and supersonic flows.
- Solve problems of isentropic flow through converging and converging–diverging nozzles.

Learning Strategy:

Lect. No	Topics	Text book Chap/Sec
37-38	Stagnation properties, Flow through Nozzle, Chocking, Normal shocks, Adiabatic and diabatic flow	17, TB1

Evaluation Scheme:

Components	Duration	Weight age (%)	Maximum Marks [200]	Date & Time	Remarks
Tutorial Tests	15 min.	20	40	Surprise	Closed book
Lecture Test	10 min.	10	20	Surprise	Closed book
Mid Semester Test	90 min.	25	50	13/10 2:00 - 3:30 PM	Open book
Team based/Game based learning	30 min	10	20	Will be announced	Open book and discussion
Comprehensive Test	180 min	35	70	12/12 FN	Closed Book

Mid-semester grading: It will be announced normally in the month of October. It is done in the same manner as that of the final grading.

Tutorials Tests: Best two will be taken out of three. Two before mid semester test and two will be after mid semester tests.

Lecture Tests: Best two will be taken out of four. Two before mid semester and two after mid semester.

Chamber Consultation Hours (Instructor Incharge): Room No.: First floor WILP. Time: 4.00-5.00 PM Wednesday

Notices: All notices related to this course will be put on the Nalanda.

Make-up Policy: Make-up will be granted for genuine cases only. Certificate from authenticated doctor from the Medical Center must accompany make-up application (*only prescription or vouchers for medicines will not be sufficient*). The make-up application must reach the I/c before commencement of the scheduled exam (mid sem/compre). **No make-up will be allowed for the tutorial tests and lecture class tests.**

Instructor-in-charge
Dr. Manoj Soni
MEF214/MFF214

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus

INSTRUCTION DIVISION

FIRST SEMESTER 2018-2019

Course Handout (Part-II)

Date: 02/08/2018

Course No. : **ME F215 / MF F215**

Course Title : **MECHANICAL ENGINEERING LABORATORY**

Instructor-in-charge : **GIRISH KANT GARG**

Instructor : Abdulla Sultan, Abhishesh Mishra, Pingale Ajay Dadabhau, Rahul Priyadarshi, Rishi Kumar, Rohit Gunerkar, Shailendra Singh, Shital Patil, .

Scope and objective of the course:

The objective of the course is to train the students in the skill of operation of instruments and equipments related to mechanical engineering, Course will mainly focus on testing of mechanical properties like tensile testing, hardness, impact, bending of beams. Basic fluid mechanics experiments like measurements of pressure, temperature, viscosity, flow measurement, basic electrical & electronics engineering like experiments on power measurements, transformers, induction motors. etc. This course will also expose the students to a broad knowledge of experimental methods and measurement techniques.

Laboratory Manual (LM): "A Laboratory Manual for MECHANICAL ENGINEERING LABORATORY (Enlarge and Edited Version of Measurement Techniques-II: TA C 222)", Digalwar, A. K. et al., EDD Notes.

Reference Books:

R1: Holman J.P., "Experimental Methods for Engineers," TATA McGRAW HILL, 7th ed., 2004.

Laboratory Plan:

Exp. No.	Name of Experiment	Ref
MEL 1	Determine the modulus of elasticity of mild steel specimen using tensile test	LM: ME 1
MEL 2	Determine the modulus of elasticity of mild steel specimen using bending test.	LM: ME 2
MEL 3	(a) Measurement of hardness of the given samples using Brinell Hardness Testing Machine and correlate them with the ultimate Tensile Strength(UTS) of the Materials (b) Measurement of hardness of the given samples using Rockwell Hardness Testing Machine	LM: ME 4 LM: ME 5
MEL 4	Verification of Bernoulli's theorem	LM: CH 5

MEL 5	Test on single phase induction motor	LM: EEE 2
MEL 6	Study of Reynold's apparatus	LM: CH 3
MEL 7	Test on single phase transformer	LM: EEE 6
MEL8	(a) To estimate and compare the shock resistance qualities of the materials by conducting Impact Test (b) Perform Torsion test to find modulus of rigidity	LM: ME 7 LM: ME 8
MEL9	(a) Study of viscosity coefficient (b) Study of polariscope	LM: CH 2 Class Notes
MEL 10	(a) To measure Flow by venturimeter and to calculate coefficient of discharge for venturimeter (b) To measure Flow by orificemeter and to calculate coefficient of discharge for orificemeter	Class Notes Class Notes
MEL11	To determine the coefficient of discharge using different notched specimens	Class Notes
MEL12	(a) To measure the principle strain on a thin walled pressure vessel by using rosette strain gauge (b) To determine critical buckling load for columns with different end support	Class Notes Class Notes

Laboratory Location: Material testing laboratory room No.: 2104

Lab Cycle Details:

Lab Cycle I : Exp No MEL 1 to MEL 6

Lab Cycle II : Exp No MEL 7 to MEL12

Evaluation Scheme:

Component	Duration	Marks	Weightage (%)	Date & Time	Remarks
Lab. Expt. 1st cycle	16 Hr	70	35	TBA	OB
Lab. Expt. 2nd cycle	16 Hr	70	35	TBA	OB
Lab. Test	01 Hr	30	15	TBA	CB
Lab Quiz	01 Hr	30	15	TBA	CB
TOTAL		**200**	**100**		

Makeup Policy: Makeup will be granted only for genuine cases:
Chamber Consultation hours: Wednesday 4:00 pm to 5.00 pm Chamber no: 2243-Q
Notices: Notices concerning the course will be displayed only on Nalanda.

Instructor-in-charge

ME F215/MF F215

SECOND SEMESTER 2018-19
COURSE HANDOUT

Date: 07.01.2019

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No	**: BITS F225**
Course Title	**: Environmental Studies**
Instructor-in-Charge	**:** PANKAJ KUMAR SHARMA
Instructor(s)	**:** Arvind K Sharma, Smita Raghuvanshi, Sandhya Marathe, Nishant Roy, Sailaja Nandigama

1. Course Description: Environment, human population, and industrialization; natural resources and the impact of man-made activities on them; structure and function of ecosystem, population ecology, biodiversity and its conservation, environmental pollution, social issues and the environment, and environmental impact assessment.

2. Scope and Objective of the Course: The United Nations Conference on Environment and Development (UNCED) held in Rio De Janeiro in 1992, the 1994 conference on United Nations Framework Convention on Climate Change (UNFCCC), and a very recent 2015 Paris Agreement have created awareness among the people around the globe about the deteriorating condition of Earth's environment. It has warned us not to be ignorant of the environmental issues. In lieu of the situation, the Hon'ble Supreme Court directed the UGC to introduce a basic course on environment for undergraduate students in India.

The course is designed to cover all aspects of environment [Ecological including biotic (fluora- fauna) and abiotic (air, water, soil & geography), social, economical and aesthetical]. The course is of interdisciplinary nature dealing with social, biological & engineering aspects of environment. The role of biotic and abiotic factors in the functioning of the environment, the impact of anthropogenic activities on the environment, different environmental pollutants, its impact and management strategies; and ecological, socio-political and economic issues will be discussed with appropriate real-life examples and case studies. The course would also provide insight into practical solutions to different environmental issues. Finally, important concepts of environmental impact assessment from all the above mentioned sources would be dealt with. The interested students can take the learning forward from this point and enrich themselves further by doing other electives/projects in these areas.

3. Text Books: T1: Erach Bharucha, Text Book Of Environmental Studies for Undergraduate Courses, University Press (India) Private Limited, Second Edition, 2005.

4. Reference Books: R1: Richard T. Wright, Dorothy F. Boorse, Gordon College, Environmental Science: Toward a Sustainable Future, Pearson Publishers, 12th Edition, 2014.

R2: Gerard Kiely, Environmental Engineering, McGraw Hill Education, Special Indian Edition, 2007.

R3: Gilbert M. Masters and Wendell P. Ella, Introduction to Environmental Engineering and Sciences, PHI Learning Private Ltd, 3rd Edition, 2007.

5. Course Plan:

Module Number	Lecture session*	Reference	Learning Outcomes
1. Introduction to Environmental Studies	L1: Introduction to the course and importance of Environment.	*T1-Unit 1 & Class notes*	Understand the modality of the course, environmental issues and its impact of life on Earth
2. Concept of ecosystems	L2: Structure of Ecosystems, Global biomes and Climate. L3: Energy and Material flow in ecosystems	*T1-Unit 3; R1 Ch-5 and 7 & Class notes*	Learn about structure and functioning of ecosystems, biomes and climate
3. Environmental Pollution	L4-5: Pollution: Air, Water, Soil, Marine, Noise, Thermal, Nuclear & Related Aspects	*T1 –Unit 5, 5.1 – 5.8& Class notes*	An overview of environmental pollution, which will unfold as details are covered
4. Air Pollution	L6: Criteria pollutants, Non criteria pollutants, Air pollution meterology, Atmospheric Dispersion L7: Methods for carbon capture sequestration and utilization	*R2 – Ch 8, 8.1, 8.3, 8.4, 8.6 - 8.10& Class notes*	Gives an understanding of different types of air pollutants, effect of atmosphere on pollutants behavior, specific case study of carbon capture sequestration and utilization
5. Environmental laws and regulations	L8-9: Legal framework of Environmental Laws & regulations pertaining to air pollution, and solid waste	R2 – Ch 1, 1.2 – 1.3, 1.6, 1.8 & class notes	Gives an over view of US-EPA laws and CPCB laws & standards followed
6. Need and importance of water resources, their utilization and pollution	L10-12: Water Cycle, Water Resources, Utilization, Pollution, Treatment, Management of Water Resources	*T1-Unit 2 & Class Notes*	Overview of the present status, distribution and utilization of water resources, factors leading to water pollution, water treatment plant. Concept of water stressed regions, disputes and conflicts over water, need for water resource management
7. Development and Regulation of Water Resources	L13-15: Sustainable Water Management	*T1-Unit 6 &Class notes*	Rain water harvesting, Innovations in irrigation techniques. Engineering considerations for construction of dams and major infrastructure projects
8. Biodiversity and its conservation	L16-18: Biodiversity, its value and measurement methods L19-20: Biodiversity crisis and conservation strategies	*T1-Unit 4; R1 Ch-6 & Class notes*	Know about the biological wealth and its value. Learn biodiversity estimation methods, understand why there is biodiversity crisis and methods/strategies for its conservation
9. Population Ecology	L21: Dynamics of natural populations L22: Mechanisms of Population Equilibrium L23-24: Response of population to environtment	*T1-Unit 7; R1 Ch-4, 8 and 9 & Class notes*	Learn about different growth curves, intra and inter-species interactions. Understand evolution as a force for change, ecosystem responses to disturbance, ecological

			succession
10. Solid waste Management	L25: Integrated Management of Solid waste, Sources of Solid Waste, Storage & Transport of MSW, Biological MSW Treatment Technqiues	*R2 – Ch14, 14.1 -14.3, 14.8-14.12*	Awareness of integrated solid waste management system in place and methodologies followed
11. Sanitation Engineering	L26: Sanitation options covering fundamentals of urban drainage and sewage L27: Non-sewered sanitation technologies	*Reports and class notes*	Awareness and sensitization about sanitation science & technologies available/ developing in developing countries
12. Env Impact Assessment: EIA	L28:Checklist method & Matrix method for EIA	*Class notes*	Understanding of impact assessment methodologies followed through case studies
13. Technologies employed for industrial air emissions control	L29: Characterizing the Air Stream, Equipment Selection, Different Types of Air Pollution Control Techniques	*R2 – Ch- 16 and Class notes*	Characterization of air stream(s), so that suitable equipment (technology) can be selected for industrial air emissions control
14. Design aspects of three major technologies for industrial air emissions control	L30-32: Equipment Design: Scrubbers Absorption Adsorption	*R2 – Ch - 16 and Class notes*	Appreciation and understanding of the principles (involved) which help in designing the equipment for the control of industrial air emission(s)
15. Environmental science and legislation	L33: Science and the Environment L34-35: Economics Politics and Public Policy	*T1-Unit 6 and 7; R1 Ch-1 and Ch-2 & Class notes*	Learn about the state of the planet, environmental science and movement, three unifying themes, moving towards a sustainable future; (environmental public policy, politics and the environment)
16. Human demography	L36-39: Human Population and Development Dynamics	*T1-Unit 6 and 7; R1 Ch-8 and Ch- 9 & Class notes*	Learn about human population ecology and development, ecological foot-print, consequences of population growth and affluence, demographic transitions, social modernization

* Guest lectures might be arranged from time to time to give students an idea about latest trends/practices in environmental sciences/engineering.

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of component (Close Book/ Open Book)
Mid-Semester Test[#]	60 Min.	30% (60 M)	14/3 2:00 -3:30 PM	CB
Comprehensive Examination	2 h	45% (90 M)	9/5 FN	CB
Assignments[*]	Variable	25% (50 M)	On regular basis	CB/OB; may be Surprise/ Announced

[#] Exact mode will be put up on Nalanda in due course of time.
[*]Exact mode of assignments would be notified during the classes.

7. Chamber Consultation Hour: It would be announced by Instructors during the class hour.

8. Notices: All the notices would be put up on Nalanda.

9. Make-up Policy: If a student is unable to appear for the Regular Test/Examination due to genuine exigencies, the student must refer to the procedure for applying for Make-up Test/Examination. Prior intimation to the course IC is necessary to avail make-up. There is NO MAKE UP for Assignments.

10. Note (if any): It shall be the responsibility of the individual student to be regular in attending classes and also maintaining the self study schedule.

Few outcomes of the course are:

- To get exposed to different components of environment,
- To understand the connectivity of different aspects of environment, and,
- To be able to apply environmental consciousness in day - to - day life.

Instructor-in-charge
Course No. BITS F225

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2018-19
COURSE HANDOUT

Date: 07.01.2019

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **ECON F211**

Course Title : **PRINCIPLES OF ECONOMICS**

Instructor-in-Charge : **GEETILAXMI MOHAPATRA**

Instructor(s) : **Rajan Pandey, Geetilaxmi Mohapatra, Monika Gupta, A. K. Giri (6165- NAB)**

Tutorial Instructors : **A. K. Giri (Tut 1), Arun Kumar (Tut 2), Rajan Pandey (Tut 3), Monika Gupta (Tut 4), Krishna Muniyoor (Tut 5), A. K. Vaish (Tut 6), Anuradha Singh (RS) (Tut 7), Jyoti Tanwar (RS)(Tut 8), Manu Sharma (RS)(Tut 9), Neha Gupta (RS)(Tut 10), Sidhi Sharma (RS)(Tut11), Taru Saigal (RS)(Tut 12), Zeeshan (RS)(Tut 13), Vaibhav Shastri (RS)(Tut14), Pratibha Saini (RS)(Tut 15).**

1. Course Description: Principles of Economics is a foundation course that introduces the fundamental concepts and tools necessary to acquire an understanding of the economic decision making of market participants such as individual households, firms, and the government. The course coverage primarily encompasses the two major areas of economics namely Microeconomics and Macroeconomics.

2. Scope and Objective of the Course: The elementary discussion concerns scarcity and allocation of resources, benefits of trade, the supply and demand model and the individual behavior concerning their utility maximization. Further, the study of the behavior of profit-maximizing firms is undertaken to establish a relationship between the cost of production and the models of supply. A brief discussion on the imperfect market such as monopoly and its variants follows to illuminate the dangers of uncontrolled market power resulting from a complete monopoly. The last part of the course focuses on the study of macroeconomics, i.e. variables at the aggregate level. Discussion on key macroeconomic variables such as the Gross Domestic Product, National Income, Inflation, Interest rate, and Money Supply etc. is primarily motivated to enable students to understand the relevance of these variables in the context of the global economy.

3. Text Books: Case Karl. E.; Fair Ray C. and Oster, Sharon E., "Principles of Economics", Pearson Education Limited, 12th Edition, 2017

4. Reference Books:

R1. Case, Karl. E.; Fair, Ray C. and Oster, Sharon E., "Principles of Economics", Pearson Education Limited, 8th Edition, 2007
R2. Samuelson, P. A. & Nordhaus, W. D., "Economics", Tata McGraw-Hill 19th Edition, 2007
R3. Lipsey, R. G. & Chrystal, K. A., "Economics", Oxford University Press, 11th Edition, 2007
R4. N. Gregory Mankiw "Principles of Economics", South Western/Cengage Learning India, 6th Edition, 2012

5. Course Plan:

Module No:	Lecture Session	Reference (TB)	Learning Outcome
	L1.1: Introduction to Economics	Ch.1and Appendix	Why study Economics?
	L2.1: Scarcity, choice and opportunity cost **L2.2:** Concept of absolute and comparative cost advantage **L2.3:** The Production Possibility Frontier and various concepts related to it	Ch.2	To introduce the concepts of scarcity, choice, constant and increasing opportunity cost in economics, PPF

Module I: Introduction, Demand Supply, Market equilibrium and consumer behavior	**L3.1:** Basic decision making units, the circular flow **L3.2:** Demand and its determinants, shift in demand **L3.3:** Supply and its determinants, shift in it and market equilibrium	Ch.3	To analyze the basic decision making units, concept of demand, supply, determinants of it, factors causing shift it and market equilibrium
	L5.1: Price elasticity of demand, types, and formula for calculating it **L5.2:** Determinants of demand elasticity and other types of elasticity of demand	Ch.5	To understand how demand responds to change in price, income and other factors, relationship between elasticity and total revenue
	L6.1: Budget constraint, utility and law of diminishing marginal utility **L6.2**: Utility maximizing rule **L6.3:** Income and Substitution effect, labour supply decision	Ch.6 and Appendix	To analyze the household behavior and consumer choice in product and input market
Module II: Production theory, cost analysis, output prices in short run and long run and input pricing	**L7.1:** The behavior of profit maximizing firms and law of diminishing returns **L7.2:** Production function with two variable factors of production	Ch.7 and Appendix	To have an clear understanding of the behavior of profit maximizing firms in both short run and long run
	L8.1: Various types of costs in the Short run and their shapes **L8.2:** Relationship between different types of cost **L8.3:**Determination of profit maximizing level of output in the by comparing costs and revenue	Ch.8	To analyze the impact of costs and revenue on profit or loss and to determine the profit maximizing/loss minimizing level of output in the short run
	L9.1: How short-run conditions affect a firm's short-run and long run behavior **L9.2:** Long run adjustments to short run conditions and derivation of long run industry supply curve	Ch.9	To discuss long-run adjustments to short run profits and losses, and how external economies and diseconomies impact the slope of long-run industry supply curve
	L10.1: Basic concepts of input market, conditions that affect supply and demand in **L10.2:** Input demand curves and the firm's profit maximizing condition in Input Markets	Ch.10	To define the basic concept of input markets and describe the relationship between supply and demand in land and labor markets
Module III: Imperfect Competition	**L11.1:** Capital, investment, depreciation, demand for new capital **L 11.2:** Investment decision, calculating present value	Ch.11 and Appendix	Analyzing the concepts of capital, investment, depreciation and explain the process of investment decision
	L13.1: Concept of imperfect competition, price and output decisions in monopoly **L13.2:** Comparison between perfectly competitive market and monopoly and Dead weight loss **L13.3:** Price discrimination	Ch.13	To discuss the price and output decisions in Monopoly, social cost of monopoly and the instances in which a monopoly charges different prices

	L14.1: Market structure in an oligopoly and the competitive forces **L14.2:** Models of oligopoly **L14.3:** Game theory	Ch. 14	To describe the structure and characteristics of oligopolistic industries, and to explain the principles and strategies of game theory
	L15.1: Characteristics and price and output determination in Monopolistic competition	Ch.15	To discuss the price and output determination in Monopolistic competition,
Module IV: Introduction to Macroeconomics	**L20.1:** Macroeconomic concerns and its elements	Ch.20	To analyze the primary concerns and the various elements of macroeconomics
	L.21.1: Concept of GDP and the value added method **L.21.2:** Expenditure method of calculating GDP **L.21.3:** Income approach of calculating GDP **L.21.4:** Nominal versus Real GDP **L.21.5:** Limitations of GDP	Ch.21	To introduce the concept of GDP, approach for measuring GDP, comparison between nominal and real GDP, and the various limitations of GDP
	L.25.1: Define money and its functions **L.25.2:** Credit creation by the banks	Ch. 25 (TB) and CH 23 (R1)/notes	To define money, role of money, banking and credit creation by the Central Bank

6. Evaluation Scheme:

Component	**Duration**	**Weightage (%)**	**Date & Time**	**Nature of component (Close Book/ Open Book)**
Mid-Semester Test	90 Min.	30%	12/3 4:00- 5:30 PM	Open Book
Surprise Tutorial test		30%	Continuous	Closed Book
Comprehensive Examination	3 h	40%	4/5 AN	Closed Book

7. Chamber Consultation Hour: Tuesday 4PM (Respective Tutorial Instructors)

8. Notices: All notices pertaining to this course shall be displayed on the Department of Economics and Finance notice board (6165-NAB) and Nalanda. Students must regularly check their BITS e-mail account for course-related announcements/notices.

9. Make-up Policy: No make-up shall be granted for the tutorial test and students will get one buffer in tutorial test.

Make-up for the mid-semester test and the comprehensive examination shall be granted only in genuine cases. The students must avail prior permission or intimate I/C before the exam is held to qualify for the make-up. In any case, original proofs justifying the absence will have to be furnished.

10. Note (if any): Students must write correct ID numbers, Section Number in all the evaluative components, failing which their answer sheets will not be evaluated.

Instructor-in-charge
Course No. ECON F211

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2018-19
COURSE HANDOUT

Date: 07.01.2019

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **ME F241, MF F241**
Course Title : **Machine Design and Drawing**
Instructor-in-Charge : **Prof. Manisankar Dasgupta**
Instructor(s) : **Dr. Gaurav Watts**
Practical Instructors : **Rahul Priyadarshi (RS), Anish Kumar (RS)**

1. Course Description:

The course introduces students to concepts and nuances of Mechanical Engineering Design. Content includes materials and design of machine elements and application of scientific principles, technical knowledge, and imaginative skills to be developed in a student. The machine elements covered are Shafts, Screw fasteners, Welded joints, Springs, Brakes & Clutches, Bearings and Gears.

The Practical classes of the course will cover fundamentals of machine drawing and solid modeling using conventional software. Practices for orthographic drawing of machine parts, sectional view, assembly drawing & exploded view included.

2. Scope and Objective of the Course:

To prepare a student of mechanical engineering to apply theory and practice of Design of Mechanical Elements. It is an introductory course laying foundation on design ground rules, application of strength of material principles, selection of components, and selection of materials for a given application. The objective also includes learning of Machine Drawing and Solid modeling**.**

3. Text Books:

T1. Budynas, R. G. and Nisbett, K. J., "*Shigley's Mechanical Engineering Design*" Tata–McGraw Hill, 10th Edition, New Delhi, 2015

T2. Cencil Jensen, Jay D. Helsel & Dennis R. Short, Engineering Drawing & Design, Tata McGraw-Hill 7th Ed. 2012.

4. Reference Books:

R1 Robert L Norton, Machine Design an integrated approach, second edition, Pearson Education Asia, 2001

R2 V B Bhandari, Design Of Machine Elements, Tata Mc-Graw Hill publishing Co, 1994

R3 Lieu D. K. and Sorby S., Visualization, Modeling and Graphics for Engineering Design, Cengage Learning, 2009

5. Course Plan:

Module No.	Lecture Session	Reference	Learning outcomes
1-2	Mechanical Engineering Design Principles, Preferred Number, Concept of Safety Factor,	Ch1	To appreciate Design Philosophy, Understand problem formulation, Design considerations and Standards.

	Engineering Units.		
3	Material considerations in design and Material Specification.	Ch2	Ability to identify the important mechanical properties for particular application /loading conditions, selection of material.
4-6	Failure resulting from static loading	Ch5	To appreciate the relationship between strength and static loading in order to make decisions concerning size and shape for satisfying the requirements of safety and reliability.
7-10	Failure resulting from dynamic loading	Ch6	To appreciate the relationship between strength and dynamic/fatigue loading in order to make decisions concerning size and shape for satisfying the requirements of safety and reliability.
11-14	Shafts	Ch7	To understand the application of principle of mechanics to locate the critical areas and evaluate the stresses so as to meet the requirements of shaft and supported elements.
15-18	Screws fasteners & non-permanent joints	Ch8	Basic understanding of the mechanics of detachable joints, strength and stiffness estimation of joint.
19-22	Weldments and permanent joints	Ch9	Basic understanding of the permanent joints, strength and stiffness estimation of joint.
23-26	Mechanical springs	Ch10	Knowledge of various types of springs and their application and designing of spring
27-30	Rolling Contact bearings	Ch11	Basic understanding of various factors involved in selection of various types of anti-friction bearings.
31-34	Lubrication and Journal bearings	Ch12	Appreciation of need of lubrication and frictional heat dissipation, Journal bearing design and criteria
35-49	Spur, helical and Bevel gears	Ch13-15	To know about various types of gears and their applications. Appreciate various design features in gears. Application of conventional and AGMA design criteria, to iteratively decide gear material, surface treatment and dimensions.
40-42	Clutches and Brakes	Ch16	Ability to analyse and design basic clutches and brakes.

Practical Sessions	**Topics**	**Reference (T2)**
1	Orthographic Drawing with basic Dimensioning	Ch8
2	Orthographic Drawing with Advanced Dimensioning	Ch8
3	Orthographic Drawing with Dimensioning and Tolerancing	Ch16
4	Sectional View, Simple Section	Ch9
5	Sectional View, Complex Section	Ch9
6	Detail & Assembly Drawing, Simple Machine part	Ch14

7	Detail & Assembly Drawing, Complex Machine part	Ch14
8	Pictorial Drawing	Ch15
9	Pictorial Drawing & Exploded view	Ch14-15
10	Solid Modeling	Ch15

6. Evaluation Scheme:

Component	**Duration**	**Weightage (%)**	**Date & Time**	**Nature of component (Close Book/ Open Book)**
Mid-Semester Test	90 Min.	20	11/3 9:00 - 10:30 AM	OB
Comprehensive Examination	3 h	40	1/5 FN	OB
Surprise Test	-	10	-	CB
Best 8 out of 10 evaluated practical marks will be taken for grading.	110 min each session	30	Designated practical hour	OB

7. Chamber Consultation Hour:

8. Notices: Online at Nalanda

9. Make-up Policy: Make-up request for Mid Semester / comprehensive examination must accompany appropriate supporting medical / exigency documents. No makeup is allowed for Surprise test and Practical components.

10. Note (if any): Attend registered sections only for practical, will not count towards evaluation otherwise.

Instructor-in-charge

Course No.

09/01/2017

In addition to part-I (general handout for all courses in the time-table), this handout provides the specific details regarding the course.

Course No.: ME F242
Course Title: I C Engines.
Instructor-in-charge: **Ravi Inder Singh**
Instructors: Sachin Belgamwar and Syam Sundar Yadav

Scope and Objective: The main aim of this course is to understand that what is physics inside the Internal Combustion Engines. This course has been designed to make the students familiar with the internal combustions engines, Air standard cycles and Actual fuel air cycles, carburetion in engines, combustion phenomenon in CI and SI engines, performance testing and measurements in IC engines, Emission control of engines, Supercharging in Engines, Non Conventional Engines and Use of Alternative fuels in Engines.

Text Book:
V.Ganesan, Internal Combustion Engines, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 4th Edition.
Reference Book:
John B. Heywoord, **"Internal Combustion Engines"**, Indian Edition, Mc Graw Hill Education.
Course Plan:

Lect. No	Learning Objectives	Topics to be covered	Ref to TB
1-2	Introduction to IC Engines	Basic Engine components and Nomenclature, Working principal of engine, classification, Application, Engine Performance Parameters and Valve timing Diagram	Ch-I
3-4	Air Standard Cycles and Their Analysis	Carnot Cycle, Otto Cycle, Diesel Cycle, Dual Cycle, Comparison of Otto, Diesel and Dual Cycle, Stirling Cycle, Ericsson Cycle and Atlinson Cycle	Ch-2
5-6	Fuel Air Cycles and their Analysis	Fuel-Air Cycles and their Significance, Composition of Cylinder Gases, Variable Specific Heats, Dissociation, Effect of Number of Moles, Comparison of Air-Standard and Fuel-Air Cycles, Effect of Operating Variables	Ch-3
7-8	Actual Cycle and their Analysis	Comparison of Air-Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blowdown, Loss Due to Gas Exchange Processes, Volumetric Efficiency, Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines	Ch -4
9-10	Carburetion	Definition of Carburetion, Factors Affecting Carburetion, Air-	Ch-7

Lect. No	Learning Objectives	Topics to be covered	Ref to TB
		Fuel Mixtures, Mixture Requirements at Different Loads and Speeds, Automotive Engine Air-Fuel Mixture Requirements, Idling Range, Cruising Range , Power Range, Principle of Carburetion, The Simple Carburetor, Calculation of the Air-Fuel Ratio, Essential Parts of a Carburetor, Compensating Devices, Types of Carburetors, Altitude Compensation	
11-12	Mechanical Injection Systems	Functional Requirements of an Injection System, Classification of Injection Systems, Fuel Feed Pump, Injection Pump, Mechanical and Pneumatic Governor, Fuel Injector and Nozzles	Ch 8
13	Electronic Injection Systems	Electronic Fuel Injection System, Multi-Point Fuel Injection (MPFI) System, Electronic Diesel Injection System and Electronic Diesel Injection Control	Ch 9
14	Combustion in SI Engines	Homogeneous and Heterogeneous Mixture, Combustion in Spark-Ignition Engines, Stages of Combustion in SI Engines, The Phenomenon of Knock in SI Engines and Factor Affecting Knocking	Ch 11
15	Combustion in CI Engines	Stages of Combustion in CI Engines, Factors Affecting the Delay Period, The Phenomenon of Knock in CI Engines and Comparison of Knock in CI and SI Engine	Ch 11
16-17	Engine Friction and Lubrication	Mechanical Efficiency, Mechanical Friction, Blow by Losses, Pumping Loss, Factors Affecting Mechanical Friction, Lubrication, Lubrication Systems, Properties of Lubricants.	Ch 12
18	Heat Rejection and Cooling	Theory of Engine Heat Transfer, Parameters Affecting Engine Heat Transfer, Types of Cooling Systems	Ch 13
19-20	Engine Emissions and Their control	Air Pollution due to IC Engines, Emission Norms, Engine Emissions, Hydrocarbon Emission, Exhaust Gas Recirculation (EGR)	Ch 14
21-22	Measurement and Testing and Performance Parameter	Friction Power, Indicated Power, Brake Power, Fuel Consumption, Air Consumption, Emission, Visible Emissions	Ch 15
23	Supercharging	Supercharging, Types Of Superchargers, Effects of Supercharging, Limitations to Supercharging	Ch 18
24	Conventional and Alternative Fuels	Fuels, Chemical Structure of Petroleum, Important Qualities of Engine Fuels, Rating of Fuels, Possible Alternatives Fuels, Alcohols, Biodiesel, Hydrogen Engines, Vegetable Oil, Dual Fuel Operation, Other Possible Fuels	Ch 5 and 6
25-26	Non Conventional Engines	Common Rail Direct Injection Engine, Dual Fuel and Multi-Fuel Engine, Free Piston Engine, Homogeneous Charge Compression Ignition Engine, Stirling Engine, Stratified Charge Engine, Variable Compression Ratio Engine, Wankel Engine	Ch 20

Evaluation Scheme:

Components	Numbers of Tests	Duration	Weightage (%)	Max. Marks 200	Date & Time	Remarks
Mid semester test.	1	90 min.	30	60	*8/3 2:00 - 3:30 PM*	Closed Book
Tutorial Tests	4	20-50 min.	20	10 Each [4* 10=40]	Surprise # Best four out of five	Open book
Class(Lecture) Performance/Participation	3	10-50 min.	15	10 Each [3* 10=30]	Surprise # Best Three out of four	Closed book
Comprehensive Examination	1	180 min.	35	70	*9/5 FN*	Closed Book

Mid-semester: Mid Semester test will be held in month of March.

Tutorials Test : Nature Open Book
Class(Lecture) Performance/participation: Based on class performance.

Comprehensive Examination: [Theory and Numerical, Eight Questions with subparts]

Chamber Consultation Hours: 4.00-5.00 PM [M, F] Chamber No. 2230
Notices: All notices related to this course will be put on the Mechanical Engineering Department notice board only or Nalanda Website.
Make-up Policy: Make-up will be given only to the genuine students. (documentary proof is essential). **No make-up will be allowed for the Tutorial tests and Class performance/participation tests.**

Dr. Ravi Inder Singh
Instructor-in-charge
ME F242 IC Engines

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2018-19
COURSE HANDOUT

Date: 07.01.2019

Course Code : **ME F243**
Name of the Course : **Production Techniques I**
Instructor-In-Charge : **K. S. SANGWAN**
Instructors (Practicals) : **Ravinder Kumar, Santosh Sarswat, Shrikant Pawar**

I. Scope and Objective of the Course

This course is designed to enrich theoretical, analytical as well as practical knowledge about metal casting, forming, welding and machining techniques used in manufacturing. Various methods in selection of proper production techniques are also included.

II. Textbook

1. Amitabha Ghosh and Asok Kumar Mallik, "Manufacturing Science", Affiliated East-West Press, New Delhi, 1985.
2. SeropeKalpakjian and Steven R. Schmid, "Manufactuirng Engineering and Technology," Pearson Education (Low Cost Indian Edition), 4/e, 2001, New Delhi.

III. Reference Books

1. Roy A. Lindberg, "Processes and Materials of Manufacture," PHI, New Delhi, 2004.
2. P. N. Rao, "Manufacturing Technology: Foundry, Forming & Welding," TMH, New Delhi, 2000.
3. P. N. Rao, "Manufacturing Technology: Metal Cutting & Machine Tools," TMH, New Delhi, 2000.
4. SeropeKalpakjian, Steven R. Schmid, "Manufacturing Processes for Engineering Materials", 4/e, Pearson Education, 2003.

IV. Course Contents

Topic	*Learning Objectives*	*Number of Lectures*	*Source*
1. Introduction	Manufacturing properties of materials, control of manufacturing properties of materials	2	T1 & T2
2. Limits, Fits and Metrology	Need of limits and fits. Types of Fits, General Metrology	2	T2
3. Metal Casting	Pattern and mould, melting, pouring, gating design, riser design	4	T1 & T2
	Various casting processes, casting defects & inspection of castings	4	
4. Metal Forming	Plastic deformation and yield criteria, mechanics of forming processes (rolling, forging, drawing, deep drawing, bending, extrusion, punching & blanking)	6	T1 & T2
	Various forming operations, hot and cold forming, friction and lubrication in forming, forming defects	3	

Topic	*Learning Objectives*	*Number of Lectures*	*Source*
5. Joining Processes	Principles of solid phase welding and liquid phase welding, soldering, brazing and adhesive bonding,	2	T1& T2
	Various welding processes, weld defects and inspection	3	
6. Metal Machining	Simple description of various machiningoperations, machine tools and cutting tool geometry.	2	T1 & T2
	Total	28	

V. Evaluation Scheme and Schedule

EC No.	Component	Duration	Weightage (%)	Date, time, venue	Nature
2	Mid-semester Test	90 min	30	15/3 9:00 - 10:30 AM	CB/OB
3	Class Room Assignments		10		OB
4	Practical		25		
5	Comprehensive exam	3 hours	35	10/5 FN	CB/OB

VI. Chamber Consultation Hour: To be announced in the class.

VII. Notices concerning the course: All notices concerning the course will be displayed on the workshop notice board.

VIII. Make-up Policy: Make-up will be permitted only in genuine cases with prior permission.

IX. Any student getting less than 10% marks of the class toper in mid sem and comprehensive examinations is liable to get an NC grade. Any student missing all quizzes will get an NC grade. Any student missing lab classes will also get an NC.

Instructor-In-Charge

ME F243

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2018-19
COURSE HANDOUT

Date: 05.01.2019

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No	**:**	ME/MF F244
Course Title	**:**	Kinematics and Dynamics of Machines
Instructor-in-Charge	**:**	J S Rathore
Tutorial Instructors	**:**	Ashish Srivastava, J S Rathore, Kiran Raj, SachinBelgamwar

1. Course Description:

Kinematic analysis of Plane Mechanisms, Velocity and Acceleration diagrams, Kinematics of Cam & Synthesis of Cam profile and Gear trains, Static and Dynamics force analysis (planar), Dynamics of reciprocating engines, Balancing, Flywheels, Governors and Gyroscopes.

2. Scope and Objective of the Course:

The first part deals with kinematics of simple mechanisms and motion generation, which lays foundation for further study in Dynamics and Vibration. The second part introduces some of basic concepts in the analysis of dynamic systems, kinetics of machine parts and vibration theory.

No	Course Objectives
CO1	To understand the kinematic analysis of lower pair mechanisms
CO2	Kinematic analysis of gear train and cam mechanisms (Higher pair mechanisms)
CO3	Static and dynamic force analysis of various mechanisms
CO4	Analysis of dynamic systems (Flywheel, gyroscope, governor etc) and importance of balancing in rotating and reciprocating mass systems

3. Text Books:

T1: Theory of Machines and Mechanisms by Uicker J.J., Pennock G.R., Shigley J.E., Oxford Univ. Press, NY, 3rd Ed., 2003.

T2: Theory of Mechanisms and Machines, Amitabh Ghosh and Ashok K. Malik, Allied East West Press Pvt. Ltd., 3rd Ed.

4. Reference Books:

R1: Mechanism Design: Analysis and Synthesis, A. Erdman and G. Sandor, Prentice-Hall, 1984.

R2: Kinematics, Dynamics and Design of Machinery, Kenneth J. Waldron and Gary L. Kinzel, Wiley India Pvt. Ltd., 2nd Ed.

5. Course Plan:

Lecture	Topics	Reference	Learning outcomes
1- 2	Introduction to Kinematics	CH 1: T1	Degree of Freedom, Types of Kinematic Joints, Inversions, Grashof's law
3-7	Vector Polygon Method for Velocity and Acceleration	CH 3 and 4: T1	Velocity and Acceleration Diagram of Kinematic Chain
8-10	Cam and Follower Systems	CH 5: T1	Different types of Cams, Motion Analysis and Motion Synthesis of Cam, Cam Profile drawing
11-14	Gear Trains	CH 10: T1	Direction of Rotation, Speed and Torque determination of Simple, Compound and Planetary gear systems
15-17	Analytical solutions of Velocity & Acceleration	CH 2, 3 and 4 (T2)	Analytical and Position Vector Method of determination of Velocity and Acceleration
18-21	Dynamic Force Analysis	CH 4 (T2)	D'Alemberts Principle, Graphical Method, Vector Method, Complex Algebra Method
22-25	Dynamics of Reciprocating Engines	CH 5 (T2)	Introduction, Gas Forces, Dynamic Analysis, Equivalent Masses, Inertia Forces, Crank Shaft, Torque Analysis
26-27	Flywheels	CH 5 (T2)	Introduction, Dynamic Theory
28-30	Gyroscopes	CH 4 (T2)	Motion of Gyroscopes, Euler's Equation
31-34	Balancing	CH 7 (T2)	Dynamic Unbalance, Single Plane, Multi-plane Balancing, Multi-cylinder Balancing
	Governors	Self-study	
35-36	Introduction to Oscillatory Motion Free Vibrations	Class notes	Basic TerminologyVibration Models, Natural Frequency, Energy Methods, Damped Free Vibrations, Logarithmic Decrement

6. Evaluation Scheme:

Evaluation Component	Duration (minutes)	Weightage	Date & Time	Nature of Component (Close Book/ Open Book)
Mid sem. Exam.	90	30%	12/3 9:00 - 10:30 AM	CB
Tutorial	50	20%	Monday 1st Hour	CB+OB
Quiz	50	10%	April, 2019	CB
Compre. Exam.	180	40%	3/5 FN	CB+OB

7. **Chamber Consultation Hour**: Friday 4 pm to 5 pm Chamber no:1210
8. **Notice**, if any, concerning the course will be displayed on the Notice Board of Mechanical Engineering Department and/or on Nalanda.
9. **Make-up Policy:** Make-up will be granted only to genuine cases. **No makeup for tutorials and quiz.**
10. **Note (if any):**Quiz exam will be conducted in the 3rd week of April, 2019.Six evaluative tutorials, each of 10 marks.

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

FIRST SEMESTER 2019-20
COURSE HANDOUT

Date: 29.07.2019

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **GS F231**
Course Title : **Dynamics of Social Change**
Instructor : **SUNITA RAINA**

Instructor(s) : **None**
Tutorial/Practical Instructors: None

1. Course Description:

This course explores how and why societies change over time, and to what effects. The dynamic process of social change has been theorized by sociologists for long. The course draws on their thought to understand various aspects of change 'in' and 'of' social structures, both in time and space.

2. Scope and Objective of the Course:

In this course, we will discuss the concept, theories, processes and consequences of social change. While the focus will be on the study of social change in general, the course will pay adequate attention to specific issues related to social change in India.

3. Text Book:
Abraham, Francis M. 2006. *Contemporary Sociology: An Introduction to Concepts and Theories.* New Delhi: Oxford University Press.

4. Reference Book:
Singh, Yogendra. 1993. *Social Change in India: Crisis and Resilience.* New Delhi: Har-Anand Publications.

5. Course Plan:

Module Number	**Lecture Sessions**	**Text Book and Reference material**	**Learning Outcome**
1. Concept of 'social change.'	Social Change as a distinct concept; Social change as a dynamic process; 'Change in structure' and 'Change of structure.'	Relevant chapters	Understanding the meaning of social change

2. Existing theories of social change.	Sociological Theory; Theories of Social Change--- Evolutionary, Structural-functionalist, and Conflict theories. Ideas on social change by the founding fathers of Sociology--- Auguste Comte; Karl Marx, Emile Durkheim and Max Weber.	Relevant chapters	Learning the ideas of prominent sociological thinkers on social change. Understanding their explanation on society and how it changes over time.
3. State as an important agent of social change.	Idea of State; State and Nation; Law and social change; State and Economy; Corporate globalization and its effects;	Relevant chapters	Understanding the meaning of 'state' and identifying its role in changing a society
4. Social stratification and social mobility	Caste System; Sanskritization; Change in the status of SCs, STs and Other Backward Classes	Relevant chapters	Recognizing the complexity of the caste system. Understanding the changes in the caste system.
5. Rural and Urban social transformation	Urbanization; Rural Migration; Urbanism as a way of Life;	Relevant chapters	Understanding the complex process of urbanization and its effects on the social fabric.
6. Recent trends in Religion	Elements of religion; Social Functions of religion; Secularization; Resacralization; Fundamentalism	Relevant chapters	Learning about the significance of religion in society. Understanding how the institution of religion has undergone changes over time.
7. Link between education and social change	Functions of education; Inequality in education; Changes in education system.	Relevant chapters	Understanding the role of education in social change. Learning about the

			mutual shaping of education and society.
8. Relationship between social movements and social change	Meaning of social movement; Types of Social Movements; Theories of social movement; Life-span of Social Movement; Social movements and change--- Environmental movement; Women's Movement; Caste-oriented movement	Relevant chapters	Understanding how social movements stimulate and spearhead social change.
9. Contradictions and challenges of social change in India	Indian 'model' of social transformation; Crisis and Resilience.	Relevant chapters	Understanding the major consequences of social change in India.

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of component (Close Book/ Open Book)
Mid-Semester Test	90 min.	30	<TEST>	Close Book
Comprehensive Examination	180 min	40	< TBA >	Close Book
Assignment/ Quizzes		30	TBA	Close Book and Open Book

7. Chamber Consultation Hour: TBA; or by prior appointment.

8. Notices: Notices concerning the course will be displayed on Nalanda, and will also be communicated to the students through email.

9. Make-up Policy: For the components of the evaluation, makeup will be allowed on the basis of documented proof to support the case. If you have a personal or medical emergency, provide copies of the appropriate paperwork to your instructor as soon as you can. Missing a due date, forgetting an assignment, or simply getting behind is not a valid reason.

10. Note (if any): Please be aware that cutting and pasting from websites is considered plagiarism. Students are advised to document all sources. If you are not sure that you need to document a source, then please ask the instructor. Any hint of plagiarism in an assignment will fetch a zero.

Instructor-in-charge
GSF231

FIRST SEMESTER 2019-2020.
Course Handout Part II

Date: 02/08/2019

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

Course No. : ME F311

Course Title: Heat Transfer

Instructor-in-charge: P.SRINIVASAN;

Instructors: Aneesh.AM, Harsh Sharma, Diplesh Gautam, Abishesh Mishra, Rahul Uke, Amresh Kumar, Vivek Tiwari, Pingale Ajay Dadabhau

Course Description: Fundamental concepts of heat transfer; steady state and unsteady state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchangers; boiling and condensation; heat transfer by radiation; associated laboratory.

Scope and Objective of The course: This course is designed to make the students familiarize with the concepts of heat transfer and its applications. As a part of this course, students have to do the experiments to correlate theoretical knowledge with the experimental results.

1. **Text Books**
   T1: JP Holman and Souvik Bhattacharyya, Heat Transfer (SI Edition), McGraw Hill Education, India, 2011,10th Edition.
2. **Reference Books**
   R1: Incropera, Dewitt, Bergmann and Lavine, Fundamentals of Heat and Mass Transfer, 6th Ed., Wiley India, 2010, 6th edition.
   R2: F. Kreith & M. S. Bohn, Principles of Heat Transfer, Brooks Cole, 2000, 6th edition.

3.Course Plan

Lecture	Learning Objectives	Topics to be covered	Ref. Chap/Sec in Text/ Ref Book
1	Recapitulate basic concepts of transport phenomena	Introduction to heat transfer	Class notes
2-4	Learn basics of conduction	Heat conduction equation	1.1 – 1.2 (T1)
5-7	Understand analysis of 1-D steady state heat conduction	1-D steady state heat conduction	2.1 – 2.8 (T1)
8-9	Understand heat transfer from extended surfaces	Extended surface heat transfer	2.9 – 2.11 (T1)
10-11	Learn heat transfer analysis of unsteady-state conduction	Lumped system analysis; analytical methods of analysis	4.1 – 4.2 (T1) 4.3 – 4.5 (T1)
12-14	Analysis of multi-dimensional steady state conduction	Analytical & numerical methods	3.1 – 3.5 (T1)
15-16	Learn principles of convection	Concepts and basic relations in convective heat transfer	5.1-5.3 (T1)
17-18	Understand forced convection heat transfer (internal flow)	Analytical solutions and empirical relations	5.10,6.1-6.2 (T1)
19-22	Understand forced convection heat transfer (external flow)	Analytical solution and empirical relations for forced convection: flat plate, cylinders, spheres, tube banks	5.4 – 5.9, 5.12, 6.3 – 6.4 (T1)

23-25	Understand natural convection	Analytical solutions and empirical correlation	7.1 – 7.12 (T1)
26-29	Learn condensation and boiling	Film and dropwise condensation, pool boiling	9.1-9.8 (T1)
30-34	Learn analysis of heat exchangers	Types of heat exchangers; LMTD and NTU method of analysis	10.1-10.9 (T1)
35-36	Understand basic laws of radiation	Basic laws and nature of thermal radiation	8.1-8.3 (T1)
36-40	Learn principles of Radiative heat transfer	Radiation heat exchange between surfaces; radiation shields; radiation network	8.4 – 8.11, 8.17 (T1)

4. Evaluation Schedule

Component	Duration	Marks (Out of 200)	Date & Time	Type
Mid semester test	90 min	50	9/10 2:00 - 3:30 PM	Open Book
Lab report & Viva	--	40		--
Lab comprehensive exam	120 min	10		Open Book
Assignment (Best 3 out of 5)	50 min	20		Open Book
Comprehensive examination	180 min	80	3/12 FN	Closed Book

5. Chamber consultation hours: Fridays 5PM to 6PM in PSD/WILP office chamber in the I Floor of Library building.

6. Notices: Notices pertaining to this course will be displayed on Mechanical Engg Dept. notice boards only. Emailed notices may be sent as well.

7.List of Experiments

Following is the tentative list of experiments. The exact list will be announced at the beginning of laboratory session along with batch number, turn of each batch etc.

No.	Experiments
1.	Development of hydrodynamic boundary layer over a flat plate
2.	Determination of thermal Conductivity of Insulating Material
3.	Determination of equivalent thermal conductivity of a composite slab
4.	Determination of critical thickness of insulation
5.	Determination of temperature distribution in fins under natural convection
6.	Determination of Temperature –Time history under transient conduction
7.	Determination of forced convection heat transfer coefficient for internal flow
8.	Determination of natural convection heat transfer coefficient from a vertical cylinder
9.	Determination of effectiveness and LMTD of a shell and tube heat exchanger
10.	Determination of temperature distribution in a pin fin under forced convection
11.	Comparison of dropwise and film condensation processes
12.	Determination of Emissivity of a test surface
13.	Determination of Stefan Boltzman constant from Radiation experiments
14.	Determination of peak heat flux for pool boiling
15.	Performance evaluation of Double pipe heat Exchanger

16.	Free and Forced Convection with VDAS- Pin-Fins
17.	Extended surface heat transfer-Pin fin

Make Up Policy: No make up for the assignments. Make up will be given to the lab and mid semester only for very genuine medical cases with proper proof.

Prof. P.Srinivasan
Instructor-in-charge
ME F311

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

FIRST SEMESTER 2019-20
COURSE HANDOUT

Date: 02.08.2019

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **ME F312**
Course Title : Advanced Mechanics of Solids
Instructor-in-Charge : **Prof. M. S. DASGUPTA**
Instructor(s) : Dr. Faizan Rashid
Tutorial Instructors : Dr. Jitendra Rathore, Dr. Arun K Jalan, Dr. Faizan Rashid

1. Course Description:

The course starts with generalized Hooke's law and three dimensional stress strain relations putting emphasis on Materials-Mechanics linkage to elucidate mechanical properties of materials. It also includes Energy methods; Torsion of non-circular members; Shear center and Asymmetrical bending of beams; Curved beams; Thick cylinders; Plates and shells; Contact stress.

2. Scope and Objective of the Course:
The course deals with in-depth analysis of some advanced topics in Mechanics of Solids, necessary for Mechanical Engineering students, beyond what is covered in the common course Mechanics of Solids.

3. Text Books:
T1: "Advanced Mechanics of Materials" - Arthur P., Boresi and R.J. Schinid, John Wiley, 6th Edition.

4. Reference Books:
R1: "Advanced Mechanics & Solids" - L.S. Srinath, Tata Mc.Graw-Hill Publishing Co. 2nd Edition, 2003

R2: "Advanced Mechanics of Solids" – Otto T. Bruhns, Springer Verlag, 2003

R3: "Advanced Mechanics of Materials" – R. Davis Cook and Warren C. Young, Prentice Hall 2nd Edition, 1998.

5. Course Plan:

Module No.	Lecture Session	Reference	Learning outcomes
1	Review of elementary Mechanics of Materials and methods of analysis, failure analysis & properties of material	CH1 (TB1)	Quick revision of important concepts in first level course on Engineering mechanics
2	Energy methods and applications	CH5 (TB1)	Ability to identify, formulate and solve variety problems of statics using energy method
3	Theories of stress and strain	CH2 (TB1)	Comprehend nuance of continuum mechanics, its

			implications and numerical problem solving.
4	Linear stress strain temperature relations	CH3 (TB1)	Computing stress and strain for isotropic and anisotropic material
5	Torsion of non-circular member	CH 6 (TB1)	Formulation and solution of stress arising out of torsion in a general structural member
6	Shear Center for thin walled beam cross sections	CH 8 (TB1)	Appreciate the concept of Shear center computation of same
7	Curved beams	CH 9 (TB1)	Appreciate the concept and compute bending stress in a beam with finite radius of curvature
8	Thick walled cylinders	CH 11 (TB1)	Appreciate industrial application of compounding of thick shell and computation of stress, strain
9	Flat Plates	CH 13 (TB1)	Formulation of elastic plate theory and solution of standard cases
10	Contact stress	CH 17 (TB1)	Hertzian contact stress, formulation and solution of basic numerical

6. Evaluation Scheme:

Component	**Duration**	**Weightage (%)**	**Date & Time**	**Nature of component (Close Book/ Open Book)**
Tutorials	50 Min	20	As announce in Timetable	OB
Surprise Tests (Quiz)	-	10	-	CB
Mid-Semester Test	90 Min.	25	<TEST_1>	OB
Comprehensive Examination	3 h	45	<TEST_C>	OB

7. Chamber Consultation Hour: To be announced in the class.

8. Notices: If any, will be displayed in Nalanda.

9. Make-up Policy: No makeup is allowed for Tutorials / Surprise test

10. Note (if any): Tutorials will be utilized for numerical problem solving and computer assisted problem solving under guidance of tutorial instructor and the same will be evaluated. Best five performances out of evaluated ones for each student will be counted towards aggregate marks.

Instructor-in-charge
Course No. ME F312

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

First Semester 2019-2020
Course Handout (Part II)

Date: 02.07.2019

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

Course No.	**: ME F313**
Course Title	**: Production Techniques-II**
Instructor In-charge	**: TUFAN CHANDRA BERA**
Practical Instructors	**: Nitish Gokhale, Santosh Saraswat, Tufan Chandra Bera**

1. Course Description

Metal cutting theory, basic metal cutting processes, mechanics of various machining processes, analysis, economics and quality control of metal cutting, Laboratory exercises in metal cutting and fabrication project. Introduction to non-traditional machining processes, mechanics and their applications. Introduction to micromanufacturing technologies, Introduction to CNC technology and CAM.

2. Scope and Objectives

- In-depth comprehension of metal cutting and machining processes which are common and versatile operations in product manufacturing.
- To nurture fresh talents and transform them to competent manufacturing engineers by studying metal cutting theory, various conventional and non-conventional machining processes in detail.
- To introduce micromachining and its recent development as a future scope of micromanufacturing along with CNC technology and CAM.
- Finally, to enrich theoretical, analytical as well as practical knowledge about metal cutting, various conventional and non-conventional machining processes.

3. Prescribed Text Book

T1. Amitabha Ghosh and Asok Kumar Mallik, "Manufacturing Science", 2nd Edition, ISBN 13: 9788176710633 affiliated East-West Press, New Delhi, 2010.

4. Reference Books

R1. Serope Kalpakjian and Steven R. Schemed, "Manufacturing Engineering and Technology," Pearson Education, New Delhi, Fourth Edition, 2001.

R2. Milton C. Shaw, "Metal Cutting Principles", Oxford University Press, Second Edition, 2005.

R3. A. Bhattacharyya, “Metal Cutting Theory and Practice", New Central Book Agency, 2000.

R4. P. C. Pandey and H. S. Shan, "Modern Machining Processes", Tata McGraw-Hill, New Delhi, First Edition 1980.

5. Course Plan

Module Number	Lecture session	Reference	Learning Outcome
1. Introduction to metal cutting and machining	L1.1.Introduction of machining and its importance in part and product manufacturing.	(T1) Ch-4.1, (R2) Ch-1 (R3) Ch-1	Realization of metal cutting and machining in part and product manufacturing. Identification of various motions in various machining processes and machined surface generation.
	L1.2 Introduction of conventional machining process, its advantages & disadvantages, machining terminology & its identification.	(T1) Ch-4.3, (R1) Ch-23 (R3) Ch-11	
	L 1.3.Various conventional machining processes. Identification of directrix & generatrix to generate machined surface.	(T1) Ch-4.3, (R1) Ch-23 (R3) Ch-11	
2. Geometry of cutting tools and tool nomenclature.	L2.1 Cutting tool material and its desired properties, cutting tool geometry and tool nomenclature.	(T1) Ch-4.2, (R1) Ch-21 (R3) Ch-3	Understanding of cutting tool geometry and tool & insert nomenclature.
	L2.2 Cutting insert nomenclature and importance of geometrical parameters in metal cutting.	(T1) Ch-4.2, (R1) Ch-21 (R3) Ch-3	
3. Theory of metal cutting	L3.1 Chip formation mechanism and various types of chips	(T1) Ch-4.3, (R2) Ch-8 (R3) Ch-4	Comprehension about interaction between tool and workpiece.

	L3.2 Mechanics of metal cutting	(T1) Ch-4.3, (R2) Ch-8 (R3) Ch-4	Mechanism of chip formation in metal cutting.
4. Determination of cutting forces	L4.1 Determination of cutting forces and Merchant's circle diagram	(T1) Ch-4.3, (R2) Ch-8 (R3) Ch-4	Understanding about various components of cutting forces and its importance in metal cutting. Determination and estimation of cutting forces.
	L4.2. Merchant's model and modified Merchant's theory.	(T1) Ch-4.3, (R2) Ch-8 (R3) Ch-4	
	L4.3 Estimation of cutting forces by energy consideration and effect of cutting parameters on chip formation	(T1) Ch-4.3, (R2) Ch-8 (R3) Ch-4	
5. Mechanics of various machining processes such as turning, shaping, milling and drilling	L5.1 Mechanics of turning	(T1) Ch-4.3, (R2) Ch-8 (R3) Ch-4	Comprehension about mechanics of common machining operations such as turning, shaping, milling and drilling.
	L5.2.Mechanics of shaping	(T1) Ch-4.3, (R2) Ch-8 (R3) Ch-4	
	L 5.3 Mechanics of end milling	(T1) Ch-4.3, (R2) Ch-8 (R3) Ch-4	
	L 5.3 Mechanics of face milling	(T1) Ch-4.3, (R2) Ch-8 (R3) Ch-4	
	L 5.3 Mechanics of drilling	(T1) Ch-4.3, (R2) Ch-8 (R3) Ch-4	
6. Thermal aspects of machining, tool life and machinability	L6.1. Thermal aspects of machining and estimation of temperature in cutting zone.	(T1) Ch-4.2, (R2) Ch-12 (R3) Ch-8	Understanding about heat generation and analysis in machining and role of cutting fluids in machining. Familiarization about
	L6.2. Tool wear mechanism	(T1) Ch-4.2, (R2) Ch-11	

		(R3) Ch-9	tool wear, tool life and machinability of workpiece.
	L 6.3 Tool life and its assessment	(T1) Ch-4.2, (R2) Ch-11 (R3) Ch-9	
	L 6.3 Machinability study	(T1) Ch-4.2, (R2) Ch-11 (R3) Ch-9	
7. Abrasive cutting processes	L7.1. Construction of grinding wheel	(T1) Ch-4.4, (R1) Ch-25 (R3) Ch-15	Comprehension about abrasive machining process and other finishing processes such as lapping and honing etc.
	L7.2. Mechanics of grinding	(T1) Ch-4.4, (R1) Ch-25 (R3) Ch-15	
	L 7.3 Honing, Lapping, Buffing and polishing operations	(T1) Ch-4.4, (R1) Ch-25 (R3) Ch-15	
8. Surface integrity and economics of machining.	L8.1 Surface integrity and surface topography	(T1) Ch-4.5, (R2) Ch-17 (R3) Ch-14	Understanding about surface integrity in machining process and economics of machining in terms of production cost and production rate.
	L8.2. Economics of machining.	(T1) Ch-4.6, (R2) Ch-1 (R3) Ch-10	
9. Non-conventional machining processes	L9.1 Preface with non-traditional machining.	(T1) Ch-6, (R1) Ch-26 (R4) Ch-1	Understanding about need of non-traditional machining in part and product manufacturing
10. Various NTM processes such as AJM, USM, ECM, EDM, EBM, LBM, PAM	L10.1 Study of AJM mechanics, applications and influence of various process variables.	(T1) Ch-6, (R1) Ch-26 (R4) Ch-1	Comprehension about various non-traditional processes.

	L10.2 Study of USM mechanics, applications and influence of various process variables.	(T1) Ch-6, (R1) Ch-26 (R4) Ch-1	
	L10.3 Study of ECM mechanics, applications and influence of various process variables.	(T1) Ch-6, (R1) Ch-26 (R4) Ch-1	
	L10.4 Study of EDM mechanics, applications and influence of various process variables.	(T1) Ch-6, (R1) Ch-26 (R4) Ch-1	
	L10.5 Study of EBM mechanics, applications and influence of various process variables.	(T1) Ch-6, (R1) Ch-26 (R4) Ch-1	
	L10.6 Study of LBM mechanics, applications and influence of various process variables.	(T1) Ch-6, (R1) Ch-26 (R4) Ch-1	
	L10.7. L10.1 Study of PAM mechanics, applications and influence of various process variables.	(T1) Ch-6, (R1) Ch-26 (R4) Ch-1	
11. Introduction to micro-manufacturing	L11.1.Preface with micro manufacturing and micro technology.	(T1) Ch-7.2, (R1) Ch-26	

Lab experiments and open ended product manufacturing.

1) Mechanics of metal cutting & chip formation.
2) Cutting force measurement in conventional lathe.
3) Geometrical accuracy measurement of a part produced in CNC lathe.
4) Practice of Form Milling by Producing A Spur Gear on conventional milling.
5) Taper turning in CNC lathe and taper angle measurement.

6) Practice of peripheral and face milling operation in VMC and surface roughness measurement

After completing this course the students will be able to

1) Select suitable conventional machining process for common part manufacturing.
2) Control machining conditions to obtain desired surface quality of a part.
3) Improve part quality by analyzing mechanics of the process using same machine tool.
4) Analyze machining cost and economics of machining in part manufacturing.
5) Select either conventional or non-conventional machining process depending upon workpiece material, quality and cost of the part.

Closed Book Test: No reference material of any kind will be permitted inside the exam hall.

Open Book Exam: Use of any printed / written reference material (books and notebooks) will be permitted inside the exam hall. Loose sheets of paper will not be permitted. Computers of any kind will not be allowed inside the exam hall. Use of calculators will be allowed in all exams. No exchange of any material will be allowed.

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of component (Close Book/ Open Book)
Mid-Semester Test	90 Min.	30%	<TEST_1>	Open Book
Comprehensive Examination	3 h	35%	<TEST_C>	Closed Book
Class Assignments & Surprise Quiz.		10%		Homework & Closed book
Lab Practical		25%		Experimentations, Fabrications

7. Chamber Consultation Hour:

To be announced in the class.

8. Notices:

All notices related to the course will be displayed on Notice Board of Mechanical Engineering Department only.

9. Make-up Policy:

Make-up will be granted **ONLY** in genuine cases with prior permission. The request application for make-up test **MUST** be reached to the Instructor-in-Charge before commencement of the scheduled test along with **DOCUMENTARY PROOF**. No make-up will be allowed for the Surprise Quiz Tests.

10. Note:

It shall be the responsibility of the individual student to be regular in maintaining the self study schedule as given in the course handout, attend lectures and the lab demonstration as per the schedule announced in Nalanda. Mid Semester Test and Comprehensive Examination are according to the Evaluation Scheme given in the respective Course Handout. If the student is unable to appear for the Regular Test/Examination due to genuine exigencies, the student must refer to the procedure for applying for Make-up Test/Examination. There is no make up for any surprise quiz or tutorial.

Instructor-in-Charge
ME F313.

SECOND SEMESTER 2019 – 2020

Course Handout part II

Date: 07/01/2020

In addition to part – I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course no:	**ME F341**
Course Title:	**PRIME MOVERS AND FLUID MACHINES**
Instructor – in – charge:	**MANOJ KUMAR S. SONI**
Instructor:	Aneesh A. M
Lab Instructors:	Vivek Tiwari, Ashish Khare, Santosh Kumar Saini, Ramesh Kumar

1. Scope and Objective of the Course:

The Course is intended to familiarize the students with theoretical analysis of energy and momentum transfer between the fluid and rotor. The working principles, design considerations, performance and application aspects of turbo machines will be dealt with. Classification, descriptive details and performance of rotary machines and reciprocating machines will be discussed.

2. Text books:

TB1: M.S. Soni; Prime Movers and Fluid machines; EDD notes.

TB2: S. S. Deshmukh & M. S. Soni; Laboratory manual for prime movers and fluid machines; EDD notes.

Reference Books:

RB1: Jagdish lal; Hydraulic Machines; Metropolitan Book Company Private limited, New Delhi; 1975; 6th Edition.

RB2: Kadambi V & Manohar Prasad; An Introduction to Energy Conversion Volume III; New Age International (P) limited; 1977.

RB3: Agarwall S K; Fluid Mechanics and Machinery; Tata McGrawhill publishing company limited, New Delhi; 1997.

3. Course Objectives:

No	Course Objectives
CO1	To understand dimensional analysis and perform dimensional analysis using suitable technique for a given problem statement
CO2	To understand model analysis of fluid machines.
CO3	To understand theory and working principles of fluid machines
CO4	The understand the theoretical analysis of energy and momentum transfer between the fluid and rotor.
CO5	The understand the theoretical analysis of positive displacement machines.
CO6	To understand design considerations, performance and application aspects of various turbo machines.

4. Course Learning Outcomes:

No	Learning Outcomes
LO1	To perform dimensional and model analysis for a given problem statement
LO2	To explain working principles of fluid machines
LO3	The analyse energy and momentum transfer between the fluid and rotor of fluid machines.
LO4	The analyse positive displacement machines.
LO5	To evaluate the performance of various turbo machines under given conditions.

5. Modular Content Structure:

Week No.	Learning Objectives	Sub-modules (SM)	Reference to Text books
M1	Introduction, To understand Dimensional analysis as applied to fluid machines. To understand the principles of similarity and model testing	SM1.1: Units and Dimensions SM1.2: Methods of Dimensional Analysis SM1.3: Dimensionless Numbers SM1.4: Similarity SM1.5: Unit Quantities SM1.6: Specific Quantities SM1.7: Dimensional Analysis for Rotating Systems SM1.8: Model Testing of Turbines and Pumps	Chapter 1 of TB1; Chapter 12 of RB1; Chapter 16 of RB3
M2	To review the basic concepts of fluid mechanics and machinery. To understand the classification of hydraulic turbines To analyse the hydraulic machine	SM2.1: Elements of a Hydroelectric Power Plant SM2.2: Classification of Turbines SM2.3: Head and Efficiencies of a Turbine SM2.4: Energy Conversion SM2.5: Fundamental Equation of Hydraulic Machines SM2.6: Pelton Turbine SM2.7: Francis Turbine SM2.8: Axial Flow Turbines SM2.9: Kaplan Turbine SM2.10: Governing of Water Turbines SM2.11: Characteristics of Turbines SM2.12: Selection of Turbines	Chapter 2 TB1 Chapter 13 of RB3; Chapter 18 of RB1
M3	To understand the classification of pumps, working principles of various pumps, Analysis of reciprocating pumps.	SM3.1: Classification of Reciprocating Pumps SM3.2: Velocity and Acceleration of Water in Suction and Delivery Pipes SM3.3: Indicator Diagram SM3.4: Effect of Acceleration Head in Suction and Delivery Pipe on Indicator Diagram SM3.5: Effect of Pipe Friction on Indicator Diagram SM3.6: Effect of Acceleration Head and Pipe Friction on Indicator Diagram SM3.7: Limitation on Maximum Speed of Reciprocating Pump SM3.8: Air Vessels SM3.9: Effect of Air Vessel on Indicator Diagram SM3.10: Work Saved with Air Vessel	Chapter 3 TB1 Chapter 14 of RB3; Chapter 20 of RB1

Week No.	Learning Objectives	Sub-modules (SM)	Reference to Text books
M4	To understand the analytical principles of centrifugal pumps	SM4.1: Centrifugal Pump System SM4.2: Classification of Centrifugal Pumps SM4.3: Fundamental Equation of Centrifugal Pump SM4.4: Power and Efficiency SM4.5: Minimum starting speed of the pump SM4.6: Variation of Euler Head with Curvature of Blades SM4.7: Maximum Suction Height SM4.8: Net Positive Suction Head (NPSH) SM4.9: Characteristics of a Centrifugal Pump	Chapter 3 TB1 Chapter 14 of RB3; Chapter 19 of RB1
M5	To understand classification; working & analytical principles of Reciprocating compressors.	SM5.1: Classification Of Compressors SM5.2: Reciprocating Compressor SM5.3: Volumetric Efficiency SM5.4: Multi-stage Compression with Inter-cooling	Chapter 4 of TB1; Chapter 15 of RB3;
M6	To understand the analytical principles of centrifugal compressors and various other compressors	SM6.1: Main Components of centrifugal compressor SM6.2: Energy Conversion SM6.3: Slip and Slip factor SM6.4: Impeller Vane Shape and Velocity Triangles SM6.5: Stagnation Values in Centrifugal Compressor SM6.6: Rothalpy SM6.7: Pressure Coefficient SM6.8: Surging and Stalling SM6.9: Centrifugal compressor characteristics SM6.10: Fans and Blowers	Chapter 4 of TB1; Chpater 15 of RB3; chapter 5 of RB2.

Week No.	Learning Objectives	Sub-modules (SM)	Reference to Text books
M7	To understand the analytical principles of axial compressors and various other compressors	SM7.1: Introduction SM7.2: Axial Flow Compressor SM7.3: Cascade Flow and Nomenclature SM7.4: Stage Velocity Triangles and Work Input SM7.5: Effect of Axial velocity on Work SM7.6: Degree of Reaction SM7.7: Small Stage or Polytropic Efficiency SM7.8: Stage loading coefficient SM7.9: Surging SM7.10: Stalling SM7.11: Axial Compressor Characteristics SM7.12: Fans and Blowers	Chapter 4 of TB1; Chapter 15 of RB3; chapter 5 of RB2.
M8	To understand thermodynamic and analytical principles behind the flow of fluids through nozzles and blade passages	SM8.1: Introduction SM8.2: Flow of Steam through nozzles SM8.3: Critical Pressure Ratio and Maximum Discharge SM8.4: Expansion of Steam Considering Friction (Nozzle Efficiency) SM8.5: Supersaturated or Meta stable flow of steam in nozzle	Chapter 5 of TB1; Chapter 3 of RB2.
M9	To understand the classification of steam turbines and basic principles of analysis To understand the analysis of various steam turbines	SM9.1: Introduction SM9.2: Classification of Steam Turbines SM9.3: Impulse Turbine SM9.4: Reaction Turbine (Impulse Reaction Turbine) SM9.5: Stage Efficiency, Turbine Efficiency and Reheat Factor SM9.6: Losses in Steam Turbines SM9.7: Governing of Steam Turbines	Chapter 8 of TB1; Chapter 4 of RB2
M10	To understand classification; working & analytical principles of gas turbines	SM10.1: Introduction to gas turbines SM10.2: Elementary Design of a turbine SM10.3: Off Design Parameters SM10.4: Three Dimensional Flows SM10.5: Gas Turbine Blading	Chapter 9 of TB2; Chapter 4 of RB2

6. Learning Plan

Contact Hour 1

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH			
During CH	SM2.1 SM2.2 SM2.3 SM2.4	Introduction SM2.1: Elements of a Hydroelectric Power Plant SM2.2: Classification of Turbines SM2.3: Head and Efficiencies of a Turbine SM2.4: Energy Conversion	Chapter 2 TB1 Chapter 13 of RB3; Chapter 18 of RB1
Post CH		Revise the content taught during CH1	

Contact Hour 2

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH1	
During CH	SM2.5 SM2.6	SM2.5: Fundamental Equation of Hydraulic Machines SM2.6: Pelton Turbine	Chapter 2 TB1 Chapter 13 of RB3; Chapter 18 of RB1
Post CH		Revise the content taught during CH2	

Contact Hour 3

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH2	
During CH	SM2.7 SM2.8	SM2.7: Francis Turbine SM2.8: Axial Flow Turbines	Chapter 2 TB1 Chapter 13 of RB3; Chapter 18 of RB1
Post CH		Revise the content taught during CH3	

Contact Hour 4

Type	Content	Topic Title	Study/HW

	Ref.		Resource Reference
Pre CH		Revise the content taught during CH3	
During CH	SM2.9 SM2.10 SM2.11 SM2.12	SM2.9: Kaplan Turbine SM2.10: Governing of Water Turbines SM2.11: Characteristics of Turbines SM2.12: Selection of Turbines Problems discussion	Chapter 2 TB1 Chapter 13 of RB3; Chapter 18 of RB1
Post CH		Revise the content taught during CH4	

Contact Hour 5

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH4	
During CH	SM3.1 SM3.2 SM3.3	SM3.1: Classification of Reciprocating Pumps SM3.2: Velocity and Acceleration of Water in Suction and Delivery Pipes SM3.3: Indicator Diagram	Chapter 3 TB1 Chapter 14 of RB3; Chapter 20 of RB1
Post CH		Revise the content taught during CH5	

Contact Hour 6

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH5	
During CH	SM3.4 SM3.5	SM3.4: Effect of Acceleration Head in Suction and Delivery Pipe on Indicator Diagram SM3.5: Effect of Pipe Friction on Indicator Diagram	Chapter 3 TB1 Chapter 14 of RB3; Chapter 20 of RB1
Post CH		Revise the content taught during CH6	

Contact Hour 7

Type	Content	Topic Title	Study/HW

	Ref.		Resource Reference
Pre CH		Revise the content taught during CH6	
During CH	SM3.6 SM3.7	SM3.6: Effect of Acceleration Head and Pipe Friction on Indicator Diagram SM3.7: Limitation on Maximum Speed of Reciprocating Pump	Chapter 3 TB1 Chapter 14 of RB3; Chapter 20 of RB1
Post CH		Revise the content taught during CH7	

Contact Hour 8

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH7	
During CH	SM3.8 SM3.9 SM3.10	SM3.8: Air Vessels SM3.9: Effect of Air Vessel on Indicator Diagram SM3.10: Work Saved with Air Vessel Problems discussion	Chapter 3 TB1 Chapter 14 of RB3; Chapter 20 of RB1
Post CH		Revise the content taught during CH8	

Contact Hour 9

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH8	
During CH	SM4.1 SM4.2 SM4.3	SM4.1: Centrifugal Pump System SM4.2: Classification of Centrifugal Pumps SM4.3: Fundamental Equation of Centrifugal Pump	Chapter 3 TB1 Chapter 14 of RB3; Chapter 19 of RB1
Post CH		Revise the content taught during CH9	

Contact Hour 10

Type	Content Ref.	Topic Title	Study/HW Resource Reference

Pre CH		Revise the content taught during CH9	
During CH	SM4.4 SM4.5 SM4.6	SM4.4: Power and Efficiency SM4.5: Minimum starting speed of the pump SM4.6: Variation of Euler Head with Curvature of Blades	Chapter 3 TB1 Chapter 14 of RB3; Chapter 19 of RB1
Post CH		Revise the content taught during CH10	

Contact Hour 11

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH10	
During CH	SM4.7 SM4.8 SM4.9	SM4.7: Maximum Suction Height SM4.8: Net Positive Suction Head (NPSH) SM4.9: Characteristics of a Centrifugal Pump Problems discussion	Chapter 3 TB1 Chapter 14 of RB3; Chapter 19 of RB1
Post CH		Revise the content taught during CH11	

Contact Hour 12

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH11	
During CH	SM5.1 SM5.2	SM5.1: Classification Of Compressors SM5.2: Reciprocating Compressor	Chapter 4 of TB1; Chapter 15 of RB3;
Post CH		Revise the content taught during CH12	

Contact Hour 13

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH12	

During CH	SM5.3 SM5.4	SM5.3: Volumetric Efficiency SM5.4: Multi-stage Compression with Inter-cooling Problems discussion	Chapter 4 of TB1; Chapter 15 of RB3;
Post CH		Revise the content taught during CH13	

Contact Hour 14

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH13	
During CH	SM6.1 SM6.2 SM6.3 SM6.4 SM6.5	SM6.1: Main Components of centrifugal compressor SM6.2: Energy Conversion SM6.3: Slip and Slip factor SM6.4: Impeller Vane Shape and Velocity Triangles SM6.5: Stagnation Values in Centrifugal Compressor	Chapter 4 of TB1; Chapter 15 of RB3; chapter 5 of RB2.
Post CH		Revise the content taught during CH14	

Contact Hour 15

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH14	
During CH	SM6.6 SM6.7 SM6.8	SM6.6: Rothalpy SM6.7: Pressure Coefficient SM6.8: Surging and Stalling	Chapter 4 of TB1; Chapter 15 of RB3; Chapter 5 of RB2.
Post CH		Revise the content taught during CH15	

Contact Hour 16

Type	Content	Topic Title	Study/HW

	Ref.		Resource Reference
Pre CH		Revise the content taught during CH15	
During CH	SM6.9 SM6.10	SM6.9: Centrifugal compressor characteristics SM6.10: Fans and Blowers Problems discussion	Chapter 4 of TB1; Chapter 15 of RB3; Chapter 5 of RB2.
Post CH		Revise the content taught during CH16	

Contact Hour 17

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH16	
During CH	SM7.1 SM7.2 SM7.3 SM7.4	SM7.1: Introduction SM7.2: Axial Flow Compressor SM7.3: Cascade Flow and Nomenclature SM7.4: Stage Velocity Triangles and Work Input	Chapter 4 of TB1; Chapter 15 of RB3; Chapter 5 of RB2.
Post CH		Revise the content taught during CH17	

Contact Hour 18

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH17	
During CH	SM7.5 SM7.6 SM7.7 SM7.8 SM7.9 SM7.10	SM7.5: Effect of Axial velocity on Work SM7.6: Degree of Reaction SM7.7: Small Stage or Polytropic Efficiency SM7.8: Stage loading coefficient SM7.9: Surging SM7.10: Stalling	Chapter 4 of TB1; Chapter 15 of RB3; Chapter 5 of RB2.
Post CH		Revise the content taught during CH18	

Contact Hour 19

Type	Content	Topic Title	Study/HW

	Ref.		Resource Reference
Pre CH		Revise the content taught during CH18	
During CH	SM7.11 SM7.12	SM7.11: Axial Compressor Characteristics SM7.12: Fans and Blowers Problems discussion	Chapter 4 of TB1; Chapter 15 of RB3; Chapter 5 of RB2.
Post CH		Revise the content taught during CH19	

Contact Hour 20

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH19	
During CH	SM8.1 SM8.2 SM8.3	SM8.1: Introduction SM8.2: Flow of Steam through nozzles SM8.3: Critical Pressure Ratio and Maximum Discharge	Chapter 5 of TB1; Chapter 3 of RB2.
Post CH		Revise the content taught during CH20	

Contact Hour 21

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH20	
During CH	SM8.4 SM8.5	SM8.4: Expansion of Steam Considering Friction (Nozzle Efficiency) SM8.5: Supersaturated or Meta stable flow of steam in nozzle	Chapter 5 of TB1; Chapter 3 of RB2.
Post CH		Revise the content taught during CH21	

Contact Hour 22

Type	Content Ref.	Topic Title	Study/HW Resource Reference

Pre CH		Revise the content taught during CH21	
During CH	SM9.1 SM9.2 SM9.3 SM9.4	SM9.1: Introduction SM9.2: Classification of Steam Turbines SM9.3: Impulse Turbine SM9.4: Reaction Turbine (Impulse Reaction Turbine)	Chapter 8 of TB1; Chapter 4 of RB2
Post CH		Revise the content taught during CH22	

Contact Hour 23

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH22	
During CH	SM9.5 SM9.6 SM9.7	SM9.5: Stage Efficiency, Turbine Efficiency and Reheat Factor SM9.6: Losses in Steam Turbines SM9.7: Governing of Steam Turbines Problems discussion	Chapter 8 of TB1; Chapter 4 of RB2
Post CH		Revise the content taught during CH23	

Contact Hour 24

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH23	
During CH	SM10.1 SM10.2 SM10.3	SM10.1: Introduction to gas turbines SM10.2: Elementary Design of a turbine SM10.3: Off Design Parameters	Chapter 9 of TB2; Chapter 4 of RB2
Post CH		Revise the content taught during CH24	

Contact Hour 25

Type	Content	Topic Title	Study/HW

	Ref.		Resource Reference
Pre CH		Revise the content taught during CH24	
During CH	SM10.4 SM10.5	SM10.4: Three Dimensional Flows SM10.5: Gas Turbine Blading	Chapter 9 of TB2; Chapter 4 of RB2
Post CH		Revise the content taught during CH25	

Contact Hour 26

Type	Content Ref.	Topic Title	Study/HW Resource Reference
Pre CH		Revise the content taught during CH25	Chapter 1 of TB1
During CH	SM1.6 SM1.7 SM1.8	SM1.6: Specific Quantities SM1.7: Dimensional Analysis for Rotating Systems SM1.8: Model Testing of Turbines and Pumps	Chapter 1 of TB1; Chapter 12 of RB1; Chapter 16 of RB3
Post CH		Revise the content taught during CH26	

7. Course plan:

Lect Nos.	**Learning Objectives**	**Topics to be covered**	**Reference**
1-2	Introduction to the course, To review the basic concepts of fluid mechanics and machinery. To understand the classification of hydraulic turbines; principles of analysis.	Introduction, Elements of a Hydroelectric Power Plant, Classification of Turbines, Head and Efficiencies of a Turbine, Energy Conversion, Fundamental Equation of Hydraulic Machines	Chapter 2 TB1 Section 2.1 to 2.6 + Class notes
3-4	To understand the analytical principles of various hydraulic turbines.	Pelton Turbine, Francis Turbine, Axial Flow Turbines, Kaplan Turbine, Governing of Water Turbines, Characteristics of Turbines, Selection of Turbines	Chapter 2 TB1 Section 2.7 to 2.13 + Class notes
5-8	To understand the classification of pumps, working principles of	Introduction; reciprocating pumps, Classification, Slip, Velocity and Acceleration of Water in Suction and	Chapter 3 TB1

Lect Nos.	Learning Objectives	Topics to be covered	Reference
	various pumps, Analysis of reciprocating pumps.	Delivery Pipes, Indicator Diagram, Effect of Acceleration Head, Effect of Pipe Friction, Limitation on Maximum Speed of Reciprocating Pump, Air Vessels, Effect of Air Vessel, Work Saved with Air Vessel	Section 3.1 and 3.2 + Class notes
9-11	To understand the analytical principles of centrifugal pumps	Classification, Fundamental Equation, Curvature of Blades, Variation in Speed and Diameter of a Centrifugal Pump, Characteristics of a Centrifugal Pump	Chapter 3 TB1 Section 3.3 + Class notes
12-13	To understand classification; working & analytical principles of various compressors.	Introduction; classification; reciprocating compressors; Multi stage compression with inter cooling	Chapter 4 of TB1; Section 4.1 to 4.3 + Class notes
14-16	To understand the analytical principles of centrifugal compressors	Velocity Triangles , Slip , Influence of Impeller Blade Shape, Stagnation Values in Centrifugal Compressor, Pressure Coefficient, Rothalpy, Surging and Stalling, Centrifugal Compressor Characteristics,	Chapter 4 of TB1; Section 4.4 + Class notes
17-19	To understand the analytical principles of Axial flow compressors and various other compressors	Cascade Flow and Nomenclature, Velocity Triangles, Work Done and Degree of Reaction, Effect of Axial velocity on Work, Degree of Reaction, Small Stage or Polytropic Efficiency, Stage Loading Coefficient , Surging, Stalling and Rotating Stall, Axial Compressor Characteristics	Chapter 4 of TB1; Section 4.5 to 4.6 + Class notes
20-21	To understand thermodynamic and analytical principles behind the flow of fluids through nozzles and blade passages.	Introduction, Flow of Steam Through Nozzles , Critical Pressure Ratio And Maximum Discharge , Expansion of Steam Considering Friction (Nozzle Efficiency), Supersaturated or Meta Stable Flow of Steam in Nozzle;	Chapter 5 of TB1; Section 5.1 to 5.5 + Class notes
22-23	To understand the classification of steam turbines and basic principles of analysis.	Introduction, Classification of Steam Turbines, Impulse Turbine, Reaction Turbine (Impulse Reaction Turbine), Stage Efficiency, Turbine Efficiency and Reheat Factor, Losses in Steam Turbines:, Governing of Steam Turbines	Chapter 7 of TB1; Section 7.1 to 7.7 + Class notes

Lect Nos.	Learning Objectives	Topics to be covered	Reference
24-25	To understand classification; working & analytical principles of gas turbines.	Introduction, Elementary Design of a turbine, Off Design Parameters, Three Dimensional Flows, Gas Turbine Blading; numerical problems.	Chapter 6 of TB1; Section 6.1 to 6.5 + Class notes
26	To understand Dimensional analysis as applied to fluid machines.	Dimensional Analysis, Dimensionless Numbers, Similarity, Unit Quantities, Specific Quantities, Dimensional Analysis for Rotating Systems, Model Testing of Turbines and Pumps	Chapter 1 of TB1 Section 1.1 to 1.9 + Class notes

8. Reading assignments:
Time to time reading assignments will be given to the students. These reading assignments are part of the course and questions may appear in tests/examinations in these portions also.

9. Evaluation Scheme:

Component	Duration	Weightage	Date & Time	Remarks
Mid Sem	90 min	25%	5th March 2020 02:00 PM - 03:30 PM	OB
Lecture Tests, Team based/Game based evaluation	10 min to 50 min	20%	Lecture hour/announced	Surprise/ announced later
Lab Compre	2 hrs	10%	Announced later	CB
Lab Reports		5%	During lab hours	
Lab Group Discussion/Viva		10%	During lab hours	
Compre	3 hours	30%	11th May 2020 8 .00AM-11.00AM	CB

10. Chamber Consultation hours: To be announced in the class.

11. Notices: All the notices related to this course will be put up put up on Nalanda only.

12. Make up Policy: Make up will be given to only to genuine cases. The request application should reach the Instructor – in – charge before commencement of scheduled test.

13. Laboratory Experiments: Following is the final list of experiments.

Cycle 1:

1. Characteristics of Centrifugal Pump.
2. A) Valve timing diagram on Petrol Engine, B) Valve timing diagram on Diesel Engine.
3. Coordinating fuel Research Engine.
4. Characteristics of Francis Turbine.
5. Verification of Fans laws.

Cycle 2:

1. Characteristics of Pelton Turbine.
2. Characteristics of Kaplan Turbine.
3. Petrol Engine with eddy current dynamometer (Morse test).
4. Performance test on Air Compressor
5. Dismantling & Assembling of Water Pump.

Instructor – in Charge/ME F341

SECOND SEMESTER 2019-2020
COURSE HANDOUT

Date: 07.01.2020

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : ME F342, MF F342
Course Title : Computer Aided Design
Instructor-in-Charge : Murali Palla
Instructor(s) : Murali Palla, Deepak Sharma
Tutorial/Practical Instructors: Murali Palla, Deepak Sharma, Arun Kumar Jalan, Venkatesh KP Rao

1. Course Description:

CAD Software and CAD Hardware, Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Students will be required to do several assignments and one CAD project.

2. Scope and Objective of the Course: Computer Aided Design (CAD) is about use of computer software and hardware to aid in creating, modifying and analyzing engineering designs. Since the birth of the first CAD software SketchPAD in early 1960s, the scope of CAD is broadening continually, in several new directions and now encompasses Computer Graphics, 3D Solid Modeling, Computational Geometry, Analysis, Virtual Reality, Generative Design etc. In this course we cover fundamentals of the following broad topics. (1) Computer Graphics: Geometric transformations and projections (2) Differential geometry and analysis of parametric curves and surfaces (2) Solid Modeling: Topology and geometry, Wireframe models, B-Rep models, CSG models (3) Computational geometry: Meshing algorithms, Delaunay Triangulations, Point member classifications etc (4) Introduction to finite element method and analysis.

3. Text Books: T1. Zeid, Ibrahim Mastering CAD/CAM TMH, 2nd edition, 2006.

4. Reference Books:

R1. Mathematical elements of Computer Graphics, Rogers and Adams, Mc-Grawhill.

R2. Mathematics for Computer Graphics Applications, M. E. Mortenson.

R3. Computer Graphics and Geometric Modeling by David Solomon, Springer Series.

R4. Introduction to Solid Modeling by M. Mantyla

R5. Solid Modeling by Shapiro (A Book chapter from the handbook of Computer Aided Geometric Design).

R6. Introduction to Finite Element Method by J. N. Reddy.

R7. A Mathematical Gift, 1: The Interplay between Topology, Functions, Geometry, and Algebra vol. 1 by Kenji Ueno

R8. Lecture notes/slides provided by I/C.

R9. Web resources to be provided after lectures.

5. Course Plan:

Module No.	Lecture Session	Reference	Learning outcomes
Introduction to CAD	A general overview of the subject, and the plan for the course, scope of the course and evaluation schemes to be discussed.	T0	Get motivated for progressing in the course.

Revie w of Matlab & C Programming	Basic commands in Matlab which are used in the course. Review of C programming. Object oriented programming in Matlab and C++.	R8	Student should write some basic programs using functions, matrix manipulations, objects and classes.
1. Geometric Transformations	(a) 2D and 3D Rotations, quaternions and rotation matrices. (b) Scaling, Shear and Translation. Homogeneous coordinates. (c) Orthographic and Perspective projections.	T1	1. Student should be able to write programs for general 3D rotations about an arbitrary axis using Rotation matrices and Quaternions. 2. Able to find the matrices for common geometric transformations such as scaling shear, translation and rotation. 3. Student should be able to find the orthographic and perspective projection of a geometric figure on any given arbitrary plane. 4. Student should appreciate the mathematical properties of such transformations.
2. Curves and Surfaces	Differential geometry of curves and surfaces Parametric curves: Bezier and B-splines and NURBS and their properties. Parametric surfaces: Tensor product surfaces, Coon's patches, Surfaces of Revolution, Sweep surfaces, Developable surfaces.	T1	1. Student should be able to write programs to create freeform surfaces using Bezier curves , B-Splines and NURBS. 2. Understand the concept of continuity and smoothness of curves and surfaces. 3. Patching different surfaces in a seamless and smooth manner.
3. Solid Modeling	-Theoretical issues concerning solid modeling. -Wireframe models. -Exhaustive enumeration, Quadtree and Octree datastructures. -Constructive Solid Geometry. Regularized Boolean operations. - B-Rep models, Introduction to Algebraic Topology, Boundary of a solid, Manifolds, Connected Sum, Projective surfaces, Orientability, Gauss-Bonnet theorem, Euler's characteristic, Eulers operators, Winged Edge Data structure.	R4 & R5	1. Student should learn the difference between Graphics representation and 3D solid modeling. 2. Student should be able to write programs for Quadtree and Octree decompositions. 3. Student should be able to write programs for Boolean operations in 2D solids and should be able to. 4. To create a topology of the solid model using Euler operators and represent the solid using boundary based representation
4. Applications of Solid modeling	Computational geometry algorithms, Delaunay triangulation, Voronoi tessellations, Structured and Unstructured mesh generation, Point membership, Geometric properties calculation, Computational Geometry libraries. STL, STEP and IGES formats.	R9	1. Know some common algorithms used in CAD. 2. Implement the algorithms in C/Matlab 3. Able to use open source and

	Softwares used for Solid modeling		commercial software for solid modeling (Suggested software: Openscad, FreeCAD
5. Introduction to Finite element method	Strong and weak statements of a boundary value problem. Variational principles. Principle of virtual work and principle of minimum potential energy. Method of weighted residuals. Finite element method. Demonstration of Finite Element Software.	R6	1. Converting PDE models into Finite Element Models 2. Use of free and commercial software for solving engineering problems.

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of component (Close Book/ Open Book)
Mid-Semester Test	90 Min.	30	3rd March 2020	Close Book
Comprehensive Examination	3 h	40	4th May 2020	20% Open book 80% Close book
Tutorials		20	TBA	Closed book
Miniproject / Assignments		10		Take home

7. Chamber Consultation Hour: 1215-O, Saturday 10 am -1pm

8. Notices: Will be communicated through Nalanda

9. Make-up Policy: No makeup will be entertained for Tutorials. One or two buffers will be provided and the best 3 tutorial totals will be considered for final evaluation.

10. Note (if any): Less than 15% marks in (Compre+Midsem) will be awarded NC.

Instructor-in-charge: Murali Palla
Course No. ME/MF F342

Date:07/01/2020

In addition to Part–I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No **:** ME F343
Course Title **:** Mechanical Vibration
Instructor-in-charge **:** Arun Kumar Jalan
Other Instructor : K P Venkatesh
Tutorial Instructor **:** A K Jalan, K P Venkatesh, J S Rathore

1. Course Description:

Small oscillations of linear dynamical systems, free and forced vibrations of single and multi degree-of-freedom systems, normal modes and orthogonality relations, generalized co-ordinates and Lagrange's equations, matrix formulation, eigen-value problem and numerical solutions, transient response of one-dimensional systems, approximate energy methods, continuous system, vibration of string, rods, bars and beams. Introduction to control systems.

2. Course Objectives:

No	Course Objectives
CO1	Provide an introduction to analytical dynamics and present Lagrange's equations of motion which is an efficient way of deriving equations of motion.
CO2	Present a matrix approach to the vibration of SDOF and MDOF systems, placing emphasis on modal analysis. To cover methods suited for automatic computation for obtaining the system response.
CO3	Response of a SDOF system under harmonic forces and transient forces.
CO4	Setting-up initial-boundary value problems for some important and fundamental structural members viz. Bars, strings, rods and beams. Analytical and approximate solutions to these problems for various loading and boundary conditions are discussed and analyzed.

3. Learning Outcomes

No	Learning Outcomes
LO1	An ability to apply mathematical knowledge to an engineering problem by developing the equations of motion for vibratory systems and solving them.
LO2	Understanding importance of how structural vibrations may affect safety and reliability of engineering systems.
LO3	An ability to use modern engineering tools necessary for engineering practice such as MATLAB.

4. Course Material

Text Book:

T1: *"Theory of Vibration with Application*", Thomson W. T., Dahleh M. D., Pearson Education, 5th Ed.

Reference Books:

R1: "*Mechanical Vibration", S S Rao,* Pearson Education, 4th Ed

R2: "Elements of Vibration analysis", Leonard Meirovitch, McGraw-Hill, Singapore, 1986.

5. Course Plan:-

Lect. No	Topics to be covered	Learning Objective	Reference Chap./Sec
1	Introduction to Oscillatory Motion	Study of Basic Terminology	T1-CH1
2-4	Free Vibrations of single degree of freedom system	Concept of natural frequency and system damping properties	T1-CH2
5-10	Harmonic Forced Vibration of SDO System	Responses due to harmonic forces and their practical application such as vibration isolation, vibration measuring instruments	T1-CH3

11-12	Transient Vibration of SDOF	Responses due to transient forces i.e. arbitrary excitations.	T1-CH4
13-15	Energy based Approaches	Study of Lagrangian Mechanics, Derive equation of motion for a discrete system	T1-CH6
16-19	System with Multi degree of freedom (2 DOF)	Modal analysis, Coupling co-ordinates, Vibration absorber	T1-CH5
20-22	Computational methods for MDOF system	Orthogonality principle, Modal analysis for MDOF system: Matrix iteration method (Iteration, & Deflation)	T1-CH 7
23-26	Approximation methods: Rayleigh's method, Dunkerley's equation, Holzer method	Approximate natural frequencies for discrete system	T1-CH 10
27-30	Vibration of continuous system: String, Rods, Beams	Study of lateral, axial and bending vibration of mechanical systems	T1- CH8
31-33	Continuous system: Approximate solution	Rayleigh's method, Rayleigh-Ritz method,	T1- CH10
34-39	Introduction to Control system	Basic Introduction of control system	Class notes

6. Evaluation Scheme:

Evaluation Components	Duration (min.)	Weightage (%)	Marks	Date and time	Remarks
Mid-sem	90	25	50	<TEST_1>	CB
Quiz	-	10	20		--
MATLAB based Test		5	10		
Tutorial	50	20	40		CB+OB
Compre. Exam	180	40	80	<TEST_C>	CB+OB
TOTAL			200		

7. Tutorial : There will be four evaluative tutorials, each of 10 marks. All are surprise in nature.

8. Chamber Consultation Hour: Tuesday 3.30 pm to 5.00 pm Chamber no: **1215-N**

9. Notices: Notice, if any, concerning the course will be displayed on the Nalanda and/or Notice Board of ME Department

Instructor-In-Charge
ME F343

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

COURSE HANDOUT
Part A: Content Design

Course Title	Supply Chain Analytics
Course No(s)	MBA G577 BITS F 433
Credit Units	
Course Author	SATYENDRA KUMAR SHARMA

Course Description

Understanding the data requirements, data sources and to figure out how to use data for the supply chain decisions for improving the supply chain surplus.

Course Objectives

No	
CO1	Gain basic understanding of the underlying concepts and building blocks related to analytics used in supply chain management. Develop solid understanding of the supply chain data bases and how analytics can be used to make supply chain decisions.
CO2	In this course students would be given basics and tool/techniques of data analytics with the domain of SCM. Students will be exposed to fundamental theories in business practice, and limitations and difficulties of supply chain management theories in solving real problems.
CO3	Understand descriptive statistics and analytics is being used to create supply chain dashboard. How the supply chain dashboard is being used for understanding the supply chain performance.
CO4	Understand the basic concepts relating to predictive analytics and how this analytics is used in building forecasting models.
CO5	Understand basic concepts relating to prescriptive analytics and optimization used in supply chain decisions. This will give deeper understanding of network flow models and vehicle routing models.

Scope and Objective

Supply chain analytics is amalgamation of supply chain management and data analytics. In this course you would be given basics and tool/techniques of data analytics with the domain of SCM. Students will be exposed to fundamental theories in business practice, and limitations and difficulties of supply chain management theories in solving real problems. The basic objective of

this course is to help students develop the skill found in competent supply chain manager as well as analyst.

Text Book

T1. Modeling supply chain by James and Shaprio Wiley publisher
T2. Data Analysis and Decision Making, Albright and Winston, 7th Edition, Cengage

Reference Books

R1. Supply Chain Analytics: Beginner's Guide Gerard Blokdyk CreateSpace Independent Publishing Platform, 07-Oct-201

R2. Supply Chain Network Design: Applying Optimization and Analytics to the ... By Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman

R3. Supply Chain Optimization Through Segmentation and Analytics Book by Gerhard Plenert
R4. Business forecasting

E –Book

Designing and managing supply chain e book

Learning Outcomes:

No	Learning Outcomes
LO1	Able to understand how various types of analytics can be used to build supply chain models for better decision making.
LO2	Compare and distinguish various supply chain metrics used for measuring supply chain performance. How the SCOR model can be used for SCP
LO3	Apply and creating dashboards for real time performance of the supply chain.
LO4	Using the forecasting tools/techniques to make good use of forecasts for demand planning
LO5	Understand the supply chain network design concepts and making supply chain network design models.
LO6	Be able to evaluate different demand scenarios to netter plan sales and operations planning.
LO7	Develop and demonstrate solutions to supply chain segmentation.
LO8	Analyze/ Evaluate real life supply chain situations and identify/ apply the appropriate analytics, tools/techniques to solve it in a optimal/ effective manner.

Lecture Plan

Lecture No.(2 hrs)	Learning Objectives	Topics to be covered	TB Chapter No.
1	Introduction to supply chain analytics	Importance of supply chain analytics and its types and various examples	T 1 chapter no.1 R1 chapter no 1
2	Describing distribution of a variable	Graphs, Numerical summary measures, Table of measures, Graphs	Class notes , T2 chapter no 2
3	Finding relationship among variables	Relationship among categorical variables, continuous variables, Pivot tables	Class notes, T2 chapter no 3 and 4
4	Probability and Probability distribution	Discrete distribution and Continuous distributions	Class notes, T2 Chapter 5
5	Data bases, Supply chain data bases	Relational databases, Creating supply chain data bases	T1 Chapter 6
6	Supply chain performance Descriptive analytics	Understanding SC key performance indicators, finding top KPI	T1 Chapter no.2
7	Predictive analytics and setting up the problem	Predictive analytics, business intelligence and challenges	T1 Chapter no. 1 and 2
8	Supply chain forecasting, studying holt, winter models	Judgmental methods, Time series forecasting, Causal methods	R4 Chapter no. 9 and 10
9	Supply chain forecasting ARIMA models	Box Jenkin Methodology, Different ARIMA Models	R4 Chapter no. 9 and 10
10	Multi echelon network optimization	Extending inventory theories to multi stage	T1 chapter no. 9, 10 and class notes
11	Introduction of Optimization modelling	Linear programming in Excel, Sensitivity analysis, Hub location models	T2 Chapter 12, 13
12	Network flow models	Shortest path problem, maximum flow and minimums cost model	T1 Chapter no. 4 and 5
13	Goal Programming	Deviation variables, Setting up GP Model in Excel	
14	Supply chain sales and operations planning	Integrating marketing and supply chain models, Resilient S & OP Models	T1 chapter no 8
15	Supply chain segmentation	How the supply chain be designed for maximizing revenues	R3
16	Vehicle routing problems	Travelling salesman problem and vehicle routing problems: exact solutions and herustucs	T1 chapter no 14
17	Supervised and Unsupervised learning	Linear regression, logistic regression and cluster analysis	R4
18	Use of Bayesian networks in supply chain	Why BBN and its applications	Class notes
19	Simulation and SC models	Basics of simulation and its types,	T1 chapter 14

		Discrete event simulation, Monte Carlo simulation, Warranty cost model, What if analysis	
20	Supply chain risk Management	Risk sources and mitigation strategies	Class notes

Experiential Learning Components:

1. This course will feature experiential learning components in the form of projects and assignments (such as forecasting modeling, simulation, etc.) that are designed to enable the participants to learn by doing. This will also form part of the Evaluation Components for the course.
2. Please note that experiential learning components are integrated into the following lectures:

Lecture No.	Topic	Experiential Learning Component
5	Forecasting	MS Excel
6	ARIMA Modelling	MINITAB
7	Network flow models	Solver Excel
12	Principal Component analysis	SPSS
13	Cluster Analysis	SPSS
15	Simulation Model	What if Analysis

3. We will be building supply chain models using different software packages, hence students need a laptop/ PC preloaded with Microsoft Excel/SPSS/MINITAB for facilitating experiential learning.

Evaluation Scheme:
Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

No	Name	Type	Duration	Weight	Day, Date, Session, Time
	Experiential learning Assignment	Online	-	15%	
	Test -1	Online		10%	
	Test -2	Online		10%	
	Test -3	Online		10%	
	Project	Closed Book	2 hours	20%	
	Comprehensive Exam	Open Book	3 hours	35%	

Note *- Evaluation components can be tailored depending on the proposed model.*

Important Information:

Syllabus for Comprehensive Exam (Open Book): All topics given in plan of study
Evaluation Guidelines:

1. For Closed Book tests: No books or reference material of any kind will be permitted. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.

2. For Open Book exams: Use of prescribed and reference text books, in original (not photocopies) is permitted. Class notes/slides as reference material in filed or bound form is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.

3. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam. The genuineness of the reason for absence in the Regular Exam shall be assessed prior to giving permission to appear for the Make-up Exam. Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self-study schedule as given in the course handout, attend the lectures, and take all the prescribed evaluation components such as Assignment/Quiz, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

FIRST SEMESTER 2020-2021
COURSE HANDOUT

Date: 16/08/2020

In addition to part I (general handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course no. : BITS F462
Course title : Renewable energy

Instructor in charge: Dr. Manoj Kumar Soni

1. Scope and objective:
A state of the art treatment of different sources of renewable energy, their utility and techno-economic assessment.

2. Text book:
Kothari, D.P., Singal, K. C., Ranjan, Rakesh, *Renewable Energy Sources and Emerging Technologies*, Second Edition, PHI Learning Private Ltd., New Delhi,2011. ISBN: 978-81-203-4470-9

3. Reference books:
1. G. N. Tiwari, and M. K. Ghosal, *Renewable energy resources: basic principles and applications*. Narosa Publishing House, 2005.
2. RETScreen International, *Clean energy project analysis: RETScreen engineering & cases textbook.* Various chapters to be downloaded from http://www.retscreen.net

4. Reading assignments:
Time to time reading assignments will be given to the students. These reading assignments are part of the course and questions may appear in tests/examinations in these portions also.

5. Course Objective:
5.1: Evaluation: Evaluate: - To determine the power output and evaluate the performance of simple thermodynamic cycles for power generation technologies in terms of thermal efficiency.

5.2: Evaluation: Evaluate: - To be able to analyze and evaluate the performance of coal based or gas based power generations technologies.

5.3: Evaluation: Estimate: To be able to estimate the performance of wind, geothermal, ocean, and solar power technologies with/without energy storage for a given geographical site, in terms of their efficiency or potential.

5.4: Analysis: Analyze: To be able to analyze bio-chemical and thermo-chemical conversion technologies of biomass and organic waste in terms of their potential and conversion efficiency.

5.5: Analysis: Analyze: To analyze and compare the performance of fuel cell technologies in terms of operating conditions, efficiency and applications.

6. Course Modules:

6.1 Module: Fundamentals of Thermodynamics and Heat Transfer

6.1.1 Module Overview:

Thermodynamics is a study of transfer of energy in the form of heat and work, energy conversion, and storage. Heat is the disordered form of energy while work is the ordered form of energy. Both are boundary phenomena, observed at system boundary and when the energy is exchanged across the system boundary. Heat transfer across the system boundary takes place by virtue of temperature difference between system and surroundings.
Thermodynamic analysis of any thermal system is governed by law of conservation of mass and basic laws of thermodynamics namely first law and second law of thermodynamics. The first law of thermodynamics, which is one of the most fundamental laws of nature dealing with the principle of conservation energy. It is quantitative in nature. It states that total quantity of energy in the universe is constant. Second law of thermodynamics deals with the quality of energy and direction of the process. It states that during transfer or transformation of energy, its quality degrades and the process occurs in the direction of degradation of energy. Entropy is a property of matter that measures the degree of disorder of the system at the microscopic level.
Heat engine is a device, operating in a cycle, converts heat into work while interacting with two thermal energy reservoirs. Refrigerator or heat pump is a device operating in a cycle, transfers energy in the form of heat from low temperature reservoir to high temperature reservoir with work input to it. Carnot cycle is the most important cycle in thermodynamics, sets the thermodynamic limit of maximum performance of a heat engine. While reversed Carnot cycle sets the thermodynamic limit of maximum performance of a refrigerator or heat pump.
This module covers introduction to thermodynamics, properties of pure substance, reversible and irreversible process, first law and second law of thermodynamics, and the basics of heat transfer.

6.1.2 Module Objectives:

6.1.2.1 Analysis: Determine: To determine the work done, change in entropy and heat transfer in a non flow system using first and second law of thermodynamics.
6.1.2.2 Analysis: Determine: To determine the work done and heat transfer in a steady flow process using first and second law of thermodynamics.
6.1.2.3 Evaluation: Evaluate: To evaluate the efficiency of a heat engine exchanging heat between two thermal reservoirs.
6.1.2.4 Analysis: Calculate: To calculate the steady state heat transfer rate within any solid body undergoing heat transfer due to conduction or convection or radiation or combined mechanisms

6.1.3 Module Units:

6.1.3.1 Unit: Introduction and First Law of Thermodynamics

6.1.3.1.1 Unit's Summary:

Thermodynamics is a science which deals with transfer of energy in the form of heat and work, energy conversion, and storage. It is associated with all activities of nature dealings with energy and matter interactions. It is based on experimental observations, which are formalized into thermodynamic laws. The first law of thermodynamics is based on the most fundamental law of nature that the energy is conserved and is a thermodynamic property.
The energy exchange can take place across system boundary in the form of heat and work. Heat is a disordered form of energy while work is the ordered form of energy. Heat is the energy crossing system boundary by virtue of temperature difference. If the energy transfer taking place across system boundary without any temperature difference or exchange of matter than the energy exchange has to be work which is crossing system boundary. Heat and work both are boundary phenomena and are never contained by the system.
When only the energy exchange takes place between system and surrounding it is called as closed or non-flow system. While if along with energy exchange if the mass is also crossing system boundary along with energy than it is called as open or flow system.
This unit introduces thermodynamic systems, heat and work. It also covers first law of thermodynamics applicable to non-flow systems and flow systems.

6.1.3.1.2 Unit's Objectives:

6.1.3.1.2.1: Analysis: Analyze: To be able to analyze thermodynamic systems around like refrigerator, oven etc. and relate their overall energy interactions in terms of heat and work.
6.1.3.1.2.2: Analysis: Determine: To apply the first law of thermodynamics to a given non flow system and determine change in energy content of it.
6.1.3.1.2.3: Analysis: Determine: To determine the energy transfer from or to a given flow system by applying first law of thermodynamics.

6.1.3.2 Unit: The working fluid

6.1.3.2.1 Unit's Summary :

The working fluid is the matter which is enclosed in the thermodynamic system boundaries and transport energy. It may be mainly in liquid, vapor or solid phase. Its behavior is very important in studying thermodynamic systems, especially when phase change takes place like in boiler, evaporator, condenser, thermal storage etc. The thermodynamics properties of the working fluids are represented in the form of thermodynamics tables which are used to analyze and evaluate thermodynamic systems like thermal power plants, refrigeration systems etc.
This unit helps to understand the behavior of working fluid in different phases, mainly liquid phase, liquid-vapor equilibrium, and superheated vapor. This will help to understand, apply, analyze and evaluate the performance of the system using thermodynamic tables of pure substance as a working fluid. It also discusses about the perfect gas and its properties.

6.1.3.2.2 Unit's Objectives:

6.1.3.2.2.1: Evaluation: Evaluate: To evaluate state of a system containing pure substance, for given any two

thermodynamic properties like pressure, temperature, and specific volume etc. using thermodynamic tables.
6.1.3.2.2.2: Evaluation: Evaluate: To evaluate thermodynamic properties of saturated liquid-vapor mixture of pure substance at a given state.
6.1.3.2.2.3: Analysis: Determine: To determine thermodynamic properties like internal energy and enthalpy of a perfect gas for a given state.

6.1.3.3 Unit: Reversible and Irreversible processes

6.1.3.3.1 Unit's Summary :

Reversible process is of very high importance in thermodynamics. It is a hypothetical process, after being taken place can be reversed without affecting system and surrounding. It is used in thermodynamic analysis of ideal heat engine which is the basis of various thermodynamic cycles on which power plants work. All natural processes are irreversible.
This unit helps to understand reversible non flow processes such as constant volume process, constant pressure process, isothermal process, adiabatic process and polytropic process. These are basic process required for thermodynamic cycles. It also covers reversible flow processes and irreversible processes.

6.1.3.3.2 Unit's Objectives:

6.1.3.3.2.1: Knowledge: Identify: To identify reversible and irreversible processes from the given set of processes.
6.1.3.3.2.2: Analysis: Determine: To determine heat transfer and work done during a non-flow reversible process.
6.1.3.3.2.3: Analysis: Determine: To determine heat transfer and work done during a reversible flow process.
6.1.3.3.2.4: Analysis: Determine: To determine the amount of fluid entering or leaving the system during a non-steady flow process.

6.1.3.4 Unit: The Second Law

6.1.3.4.1 Unit's Summary :

The limitation of the first law of thermodynamics is, it is insensitive to the direction of a process. All natural process are unidirectional. Second law of thermodynamics states the direction in which the process is possible. Entropy is a thermodynamic property, can be produced but never be destroyed as per second law of thermodynamics. Temperature - entropy plot, also known as T-s plot, is widely used to represent thermodynamic properties and processes for a pure substance as well as a perfect gas.
This unit helps in understanding forward and reversed heat engine (heat engine and heat pump). Two classical statements of second law of thermodynamics are explained using them. It also covers entropy as a thermodynamic property and discusses T-s plot for a pure substance and a perfect gas. Reversible processes like isothermal, isentropic and poly tropic process are also being discussed using T-s plot.

6.1.3.4.2 Unit's Objectives:

6.1.3.4.2.1: Evaluation: Evaluate: To evaluate the efficiency of a heat engine or coefficient of performance (COP) of a heat pump/refrigerator (reversed heat engine) having heat exchange between two thermal reservoirs.
6.1.3.4.2.2: Analysis: Determine: To determine the entropy of a pure substance or a perfect gas using thermodynamic tables.
6.1.3.4.2.3: Analysis: Determine: To determine change in entropy, heat transfer and work done for reversible isothermal, polytropic and isentropic process for a perfect gas.

6.1.3.5 Unit: The Basics of Heat Transfer

6.1.3.5.1 Unit's Summary :

Heat transfer deals with predicting the energy transfer that may take place between any two materials as a result of difference in temperature. Thermodynamics considers this energy transfer as heat. The heat transfer explains how heat energy is transferred and also predicts the rate at which the exchange takes place under certain specified conditions. Thermodynamics guides weather heat flow will occur or not based on system equilibrium, whereas heat transfer provides rate at which energy is transferred and also explains the mechanisms of heat transfer. This unit covers basic mechanisms of heat transfer i.e. conduction, convection and radiation.

6.1.3.5.2 Unit's Objectives:

6.1.3.5.2.1: Analysis: Calculate: To calculate the steady state heat transfer rate within any solid body undergoing heat transfer due to conduction
6.1.3.5.2.2: Analysis: Calculate: To calculate the steady state heat transfer rate between any two bodies (liquid and solid/gas and solid/liquid and gas) undergoing heat transfer solely due to convection between them
6.1.3.5.2.3: Analysis: Calculate: To calculate the steady state heat transfer rate between any two bodies (both solids/liquid and solid/gas and solid/liquid and gas) undergoing heat transfer due to combined mechanism of conduction/convection between them
6.1.3.5.2.4: Analysis: Calculate: To calculate the steady state heat transfer rate between any two bodies undergoing heat transfer due to radiation.

Module learning Strategy for Self Learning:

SN	Unit	Reference
1	Introduction and First Law of Thermodynamics	• **Book:**T D Eastop; A McConkey, Applied thermodynamics for engineering technologists, Pearson Education Ltd., Fifth edition, Chapter 1, page 21 to 39 • **Web link:MIT OPENCOURSEWARE:** Prelude: Introduction and Review of Unified Engineering Thermodynamics(as accessed on 9th October 2016) • **Web link:ENSC 388 Engineering Thermodynamics and Heat Transfer :** Introduction and Basic Concept (as accessed on 9th October 2016) • **Web link:** First Law of Thermodynamics:Closed Systems • **Web link:** First Law of Thermodynamics:Control Volume

SN	Unit	Reference
2	The working fluid	• **Book:**T D Eastop; A McConkey, Applied thermodynamics for engineering technologists, Pearson Education Ltd., Fifth edition, Chapter 2, page 47 to 59 • **Web link: ENSC 388 Engineering Thermodynamics and Heat Transfer :**Properties of Pure Substance(as accessed on 9th October 2016)
3	Reversible and Irreversible processes	• **Book:**T D Eastop; A McConkey, Applied thermodynamics for engineering technologists, Pearson Education Ltd., Fifth edition, Chapter 3, page 71 to 98
4	The Second Law	• **Book:**T D Eastop; A McConkey, Applied thermodynamics for engineering technologists, Pearson Education Ltd., Fifth edition, Chapter 4, page 108 to 235 • **Web link:MIT OPENCOURSEWARE:** The Second Law of Thermodynamics(as accessed on 9th October 2016)
5	Basics of Heat Transfer	• Nag, P.K., "Basic and Applied Thermodynamics", Tata McGraw Hill Education, New Delhi. Pg no: 568 - 600 • Holman, J.P. & Bhattacharyya, S., "Heat Transfer" Tata McGraw Hill Education, New Delhi. Pg no: 1-30

6.2 Module: Conventional Power Generation Technologies

6.2.1 Module Overview:

Electricity is most important blessings of science for the world. Thermal, nuclear and hydro are the three main sources of energy utilized in conventional power plants. Thermal energy is converted into useful work using a device called as heat engine operating on a thermodynamic cycle. The heat engine when coupled to electric generator produces electricity. Petrol, diesel and gas based engines generates power using internal combustion engines operating on thermodynamic air standard cycles. While thermal power plants like coal based and gas/liquid based, generates power using external combustion heat engines operating on vapor and gas power cycles respectively.

In nuclear power plant, instead of combustion of fossil fuel (coal, natural gas etc), the heat source is energy generated during nuclear fission reaction in reactor. In coal based and nuclear power plant the heat generated in the furnace or nuclear reactor is utilized to convert water into steam. This steam then drives the turbine-generator unit generating electricity. The steam is then condensed and pumped back and the cycle is repeated.

Hydroelectric power plants convert potential energy of water stored in the reservoirs or kinetic energy of flowing water into mechanical power by using hydraulic turbines. The selection of type of hydraulic turbine depends upon the head and discharge available at a particular site.

Majority of power generated in the world is coming from these conventional power sources and generation technologies. This module covers technologies using heat engines operating on air standard cycles, steam cycles, and gas turbine cycles. It also covers nuclear and hydro power generation technologies.

6.2.2 Module Objectives:

6.2.2.1 Evaluation: Evaluate: To evaluate performance of regenerative Rankine cycle operating with one open and one closed feed water heater.
6.2.2.2 Evaluation: Evaluate: To evaluate combined effect of multistage compression with inter-cooling, multistage expansion with reheat, and regeneration on performance of gas turbine cycle.
6.2.2.3 Evaluation: Evaluate: To evaluate performance of a given hydraulic turbine in terms of its discharge, work done, hydraulic efficiency and overall efficiency.

6.2.3 Module Units:

6.2.3.1 Unit: The heat engine cycle

6.2.3.1.1 Unit's Summary :

Heat engine is a device which gives net work output by exchanging heat between two thermal reservoirs. Such heat engines operate on thermodynamic cycles often called as heat engine cycles. If the working fluid is gas these cycles are called as Gas power cycles. Carnot cycle is the most efficient heat engine cycle. It is of great importance in analysis of heat engine cycles as it sets the upper limit of thermal efficiency.
Air standard cycles are the heat engine cycles with air as working fluid. Otto, diesel and Dual are basic thermodynamic cycles of internal combustion heat engines. All these cycles have efficiency less than Carnot efficiency. Stirling and Ericsson cycles may have efficiency same as that of Carnot cycle if a perfect regeneration is incorporated.
This unit covers the basic heat engine thermodynamic cycles and their analysis.

6.2.3.1.2 Unit's Objectives:

6.2.3.1.2.1: Evaluation: Evaluate: To analyze Carnot cycle for a perfect gas using P-v and T-s plot and evaluate its performance using first law of thermodynamics.
6.2.3.1.2.2: Evaluation: Evaluate: To evaluate the performance of air standard internal combustion heat engine cycles in terms of thermal efficiency and net work output.
6.2.3.1.2.3: Evaluation: Evaluate: To evaluate and compare the thermal efficiency of regenerative Stirling/Ericsson cycle with that of Carnot cycle.

6.2.3.2 Unit: Steam cycle-1

6.2.3.2.1 Unit's Summary :

Thermal power plants generate power continuously by converting energy in the fuel (coal, uranium) into work. In such plants, water is used as a working fluid. It is heated in the boiler and converted into steam by using heat generated by burning coal in the furnace or nuclear fission reaction in nuclear reactor. This saturated or super-heated steam is then supplied to steam turbine where it expands and rotates the turbine producing mechanical power. The turbine is coupled to electric generator produces electricity. The steam coming out of turbine is sent to condenser where it is converted into saturated liquid at condenser pressure by rejecting heat to cooling water. The saturated liquid coming out of condenser is fed to feed water pump which pumps it to boiler pressure and then supplied to boiler and the cycle is repeated. The thermodynamic

cycle on which such plants operate is Rankine cycle. As a working fluid, water has high enthalpy of evaporation and cheaply available in abundance, nontoxic, non-corrosive, hence desirable working fluid. This unit covers Rankine cycle and its analysis.

6.2.3.2.2 Unit's Objectives:

6.2.3.2.2.1: Evaluation: Evaluate: To analyze ideal Rankine cycle for a vapor power plant using T-s plot and evaluate thermal efficiency by applying first law and second law of thermodynamics.
6.2.3.2.2.2: Evaluation: Evaluate: To evaluate performance of Rankine cycle considering isentropic efficiencies of turbine and pump.
6.2.3.2.2.3: Analysis: Diagram: To represent the Rankine cycle processes on the Mollier diagram (enthalpy-entropy chart).

6.2.3.3 Unit:Steam cycle-2

6.2.3.3.1 Unit's Summary :

Steam power plants have lion's share in the power generation in the world in general and in India in particular. The major issue with these power plants is they contribute to large chunk of carbon emission. In order to improve the performance of these plants it is always desirable to improve the efficiency of such plants in order to reduce fuel consumption and hence carbon emission. Rankine cycle is the basic thermodynamic cycle on which these plants operates. The efficiency of Rankine cycle is a function of average temperature of heat addition. Higher the average temperature of heat addition, higher will be the efficiency of the Rankine cycle. Higher value of this temperature is achieved by modifying basic Rankine cycle by incorporating reheat and regeneration cycle. The efficiency can also be improved by low value of the temperature at which heat is rejected, but it is limited by the ambient temperature.
This unit covers modifications of Rankine cycle in order to have higher thermal efficiency.

6.2.3.3.2 Unit's Objectives:

6.2.3.3.2.1: Evaluation: Evaluate: To analyze reheat Rankine cycle for a vapor power plant using T-s plot and evaluate its performance by applying first law of thermodynamics.
6.2.3.3.2.2: Evaluation: Evaluate: To evaluate performance of regenerative Rankine cycle using an open feed water heater.
6.2.3.3.2.3: Evaluation: Evaluate: To evaluate performance of regenerative Rankine cycle using a closed feed water heater.

6.2.3.4 Unit:Gas Turbine cycle-1

6.2.3.4.1 Unit's Summary :

Gas power plants operates on gas turbine cycle (GTC), which also has two constant pressure process and two reversible adiabatic processes like Rankine cycle. But in GTC, the working fluid remains in the gaseous form throughout all the processes of the cycle. The thermodynamic cycle for gas turbine power

plant is Brayton cycle. In this cycle, both compression and expansion process takes place in rotary devices called as compressor and turbines respectively. Gas turbine power plants generally operates in open cycle, where fresh air is inducted in compressor at ambient condition, is compressed isentropically in compressor to raise its pressure and temperature. Fuel is burnt in this compressed air at constant pressure in the combustor. The high pressure and high temperature flue gases then isentropically expands in the turbine producing power. The exhaust gases coming out of turbine are vent off to the atmosphere.
The gas turbine power plants are compact and lighter as compared to vapor power plants, hence are suitable for aerospace applications. Gas turbine power plants operates on gaseous or liquid fuels.
The major drawback of GTC is high compression work, it consumes major chunk of gas turbine work. Also the efficiencies of these components plays a vital role in the overall performance of the plant. The cycle efficiency is very sensitive to turbine and compressor efficiencies. The performance of GTC can be improved by incorporating multistage compression with inter-cooling, multistage expansion with reheat, and regeneration.
This unit covers GTC and its performance analysis for simple case, considering component efficiencies, and modifications to the cycle for improvement in performance.

6.2.3.4.2 Unit's Objectives:

6.2.3.4.2.1: Evaluation: Evaluate: To analyze gas power cycle for a gas turbine power plant using T-s plot and evaluate thermal efficiency by applying first law and second law of thermodynamics.
6.2.3.4.2.2: Evaluation: Evaluate: To analyze a gas power cycle considering isentropic efficiencies of compressor and turbine, and evaluate its performance in terms of thermal efficiency by applying first law of thermodynamics.
6.2.3.4.2.3: Evaluation: Evaluate: To evaluate individual effects of multistage compression with intercooling, and multistage expansion with reheat on performance on a simple gas turbine cycle in terms of its efficiency.

6.2.3.5 Unit:Gas Turbine cycle-2

6.2.3.5.1 Unit's Summary :

Vapor power plant is a heat engine which converts some part of heat supplied from source at high temperature into work and rejecting the remaining heat to the sink (atmosphere) as waste heat at low temperature. Since this is a low grade energy, extracting useful work out of it is practically difficult. But many applications, requires heat like process heat as in paper, cement, steel, sugar and other industries. The power plant which provides both electricity and process heat is called a cogeneration plant. This are widely used in process industries as they are very economical.
In gas turbine plant, the flue gases enter turbine at very high temperature (1000-1400^{o}C) and as gas turbines are compact, the flue gases leave the turbine at very high temperature (400-600^{o}C). Since the volumetric flow rate through the gas turbine is very high, the exhaust flue gases have large amount of energy at high temperature. Some part of this energy may be recovered in regenerator, but with limited improvements in overall cycle. This energy may be recovered in a device called as heat recovery steam generator (HRSG), which is nothing but a boiler for the steam cycle plant. The steam then expands in turbine and then condensed in condenser by rejecting heat to atmosphere and the condensate is then pumped back to the HRSG. Such system is called as combined cycle. Here the topping cycle, operating in high

temperature range, is Brayton cycle (gas turbine cycle) and bottoming cycle, operating in low temperature range, is Rankine cycle (steam cycle). If both the cycles, i.e. topping and bottoming cycle are Rankine cycles then such system is called as Binary vapor cycle. Thermal efficiencies of such systems is much higher than the individual cycles.
This unit covers cogeneration system, and combined cycle and binary cycle thermal power plants.

6.2.3.5.2 Unit's Objectives:

6.2.3.5.2.1: Evaluation: Evaluate: To evaluate the effect of regeneration on performance of simple gas turbine cycle.
6.2.3.5.2.2: Evaluation: Evaluate: To analyze combined gas-steam power plant using first and second law of thermodynamics and evaluate its thermal efficiency.
6.2.3.5.2.3: Evaluation: Evaluate: To analyze binary steam power plant using first and second law of thermodynamics and evaluate its thermal efficiency.

6.2.3.6 Unit:Nuclear Power

6.2.3.6.1 Unit's Summary :

The nuclear power plant is similar to that of thermal power plant except the fact that the heat source, instead of combustion of fossil fuel (coal, natural gas etc.), is nuclear fission reaction in reactor. In nuclear power plant nuclear fission takes place inside reactor core. Here fissile fuel (generally Uranium 235) goes through nuclear fission reaction in a controlled manner. In order to have higher energy output than input the reaction should be chain reaction. This process generates large amount of heat which is utilized to boil water into steam in . This steam drives the turbine which rotates the generator to generate electricity. The steam is then condensed into the condenser and pumped back to the reactor. The issue with such power plants is disposal of nuclear waste generated due to nuclear fission, as this waste is very radioactive.

6.2.3.6.2 Unit's Objectives:

6.2.3.6.2.1: Analysis: Differentiate: To be able to differentiate between pressurize water reactor and boiling water reactor in terms of their working principle, advantages and disadvantages.
6.2.3.6.2.2: Comprehension: Explain: To be able to explain liquid metal fast breeder reactor in terms of its working principle, advantages and disadvantages.
6.2.3.6.2.3: Comprehension: Explain: To be able to explain CANDU reactor with a neat sketch.

6.2.3.7 Unit:Hydro Power-1

6.2.3.7.1 Unit's Summary :

Hydro power plants converts energy of water flowing through the turbines into mechanical energy which in turn is converted into electricity. The water stored in the natural reservoirs at higher level is used. If natural reservoir is not available then large amount of water flowing through river can be stored artificial reservoir by constructing dam across the river. The water is brought from reservoir to the turbine through a pipe called as penstock. The potential energy of water or head is utilized to rotate hydraulic

turbine to produce mechanical power. Hydraulic turbines are prime movers which are coupled to generators to produce electricity.
Pelton turbine is an impulse turbine, works on the principle of impulse action. Generally used for high head installations. This unit covers hydro electric power plant, its advantages, disadvantages, essential components and classification. It
also covers Pelton turbine and its analysis.

6.2.3.7.2 Unit's Objectives:

6.2.3.7.2.1: Comprehension: Describe: To describe hydroelectric power plant with respect to all its essential elements and state its advantages and disadvantages.
6.2.3.7.2.2: Comprehension: Classify: To classify hydroelectric power plant according to available head, nature of load and quantity of water available, direction of flow of water, specific speed etc.
6.2.3.7.2.3: Evaluation: Evaluate: To evaluate performance of Pelton turbine in terms of its hydraulic efficiency.

6.2.3.8 Unit:Hydro Power-2

6.2.3.8.1 Unit's Summary :

Medium and low heads reaction turbines are used. In turbines water flows over the blades which are mounted on a rotating wheel called as runner. When the water flows over the runner blades, the kinetic head and pressure head changes, this results energy transfer partly due to impulse action and partly due to reduction in pressure causing a reaction on turbine blades, such turbines are called as reaction turbines. The runner is enclosed in a pressure casing as pressure decreases from inlet to outlet. Francis, Kaplan, propeller and bulb turbines are reaction turbines.
Turbines are generally designed to work at certain discharge, head, power, efficiency and speed. But due to variation in operating conditions like load, available head etc. They are often required to work on conditions other than design conditions. The behavior of turbine under varying conditions are provided by manufacturers in terms of plots called as characteristic curves.
This unit covers reaction turbines. It also covers governing and performance characteristics of hydro turbines.

6.2.3.8.2 Unit's Objectives:

6.2.3.8.2.1: Evaluation: Evaluate: To evaluate performance of Francis turbine in terms of its discharge, work done and hydraulic efficiency.
6.2.3.8.2.2: Evaluation: Evaluate: To evaluate performance of Kaplan or propeller turbine in terms of its discharge, work done and hydraulic efficiency.
6.2.3.8.2.3: Analysis: Compare: To compare performance characteristic curves of hydraulic turbines.

Module learning Strategy for Self Learning:

SN	Unit	Reference
1	The heat engine cycle	• **Book:** T D Eastop; A McConkey, Applied thermodynamics for engineering technologists, Pearson Education Ltd., Fifth edition, Chapter 5, page 145 to 163 • **Web link:NPTEL:** Gas power cycle, (as accessed on 9th October 2016 • **Web link: MIT OPENCOURSEWARE:** Gas Power and Propulsion Cycles (as accessed on 9th October 2016) • **Web link: MIT OPENCOURSEWARE:** Heat Engines (as accessed on 9th October 2016)
2	Steam cycle-1	• **Book:** T D Eastop; A McConkey, Applied thermodynamics for engineering technologists, Pearson Education Ltd., Fifth edition, Chapter 8, page 254 to 267 • **Web link: NPTEL:** Vapor Power Cycle (as accessed on 9th October 2016) • **Web link: NPTEL:** Power Cycle Cont., Vapour Power Cycle, (as accessed on 9th October 2016) • **Web link: MIT OPENCOURSEWARE:** Power Cycles with Two-Phase Media (as accessed on 9th October 2016)
3	Steam cycle-2	• **Book:** T D Eastop; A McConkey, Applied thermodynamics for engineering technologists, Pearson Education Ltd., Fifth edition, Chapter 8, page 268 to 275 • **Web link: NPTEL:** Vapor Power Cycle (as accessed on 9th October 2016) • **Web link: NPTEL:** Power Cycle Cont., Vapour Power Cycle, (as accessed on 9th October 2016) • **Web link: MIT OPENCOURSEWARE:** Power Cycles with Two-Phase Media (as accessed on 9th October 2016)
4	Gas Turbine cycle-1	• **Book:** T D Eastop; A McConkey, Applied thermodynamics for engineering technologists, Pearson Education Ltd., Fifth edition, Chapter 9, page 280 to 289 • **Web link: NPTEL:** Gas Turbine Cycle (as accessed on 9th October 2016) • **Web link: MIT OPENCOURSEWARE:** Gas Power and Propulsion Cycles (as accessed on 9th October 2016)
5	Gas Turbine cycle-2	• **Book:** Y. A. Cengel, M.A. Boles, Thermodynamics: An Engineering Approach, Chapter 10, Eighth edition, McGraw-Hill Education (India) Pvt. Ltd., page 579 to 589 • **Book:** T D Eastop; A McConkey, Applied thermodynamics for engineering technologists, Pearson Education Ltd., Fifth edition, Chapter 9, page 290 to 303 • **Web link: NPTEL:** Gas Power Cycle (as accessed on 9th October 2016)
6	Nuclear Power	• **Book:** Nag P.K., "Power Plant Engineering", Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 9, Page no: 632 to 648.
7	Hydro Power-1	• **Book:** Nag P.K., "Power Plant Engineering", Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 10, Page no: 657 to 688.

SN	Unit	Reference
		• **Web link: NPTEL:** Fluid Machinery - Impulse turbine(as accessed on 14th October 2016)
8	Hydro Power-2	• **Book:** Nag P.K., "Power Plant Engineering", Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 10, Page no: 689 to 709. • **Web link: NPTEL:** Fluid Machinery - Francis turbine (as accessed on 14th October 2016) • **Web link: NPTEL:** Fluid Machinery - Kaplan turbine (as accessed on 14th October 2016) • **Web link: NPTEL:** Fluid Machinery - Performance Characteristics (as accessed on 14th October 2016)

6.3 Module:Geothermal Energy Technologies

6.3.1 Module Overview:

Geothermal energy word is a combination of geo (earth) and therme (heat) i.e. it is the heat within the earth. The primary source of this heat within the earth is the decay of radioactive isotopes of thorium, uranium, and potassium in the earth's crust. The earth's outer core molten or liquid while inner core is considered to solid containing nickel-iron alloy. The heat flows from the core to the surface primarily due to conduction heat transfer.

The temperature of the earth increase from its surface to the core, the temperature increases at about 30^{O}C per km. This temperature gradient is very high near the active volcanic sites. By measuring this temperature gradient, the rate of heat transfer from earth to the surface at a particular site can be estimated. Geothermal energy comes out of earth's crust in the form of hot springs or geysers. It can also be extracted by drilling the impermeable rock which is preventing the pressurized hot water to come out. In case of hot dry rock reservoirs, a pair of well is drilled in the fractured impermeable rock at sufficient distance apart. Water is injected in one well and hot water is returned to the surface from other well.

This geothermal energy coming out in the form of hot water or steam from a geothermal source can be used to generate electricity in Rankine cycle based thermal power plant, industrial applications in process heating using steam, and also in space heating and district heating.

6.3.2 Module Objectives:

6.3.2.1 Evaluation: Estimate: To be able to estimate the energy content and possible years of operation of a given type of geothermal site at a given condition like temperature and volumetric specific heat.

6.3.2.2 Evaluation: Estimate: To be able to estimate the useful heat content, time constant of useful energy extraction and the extraction rate initially and after given years, of a given dry rock geothermal site at a given condition depth and temperature gradient.

6.3.2.3 Comprehension: Explain: To be able to explain with a neat sketch the given type of geothermal application like power plant or heat pump system.

6.3.3 Module Units:

6.3.3.1 Unit:Geothermal Resources and their Utilization

6.3.3.1.1 Unit's Summary :

Geothermal energy is the energy in the form of heat coming from the earth's core which is at extremely high temperatures. This energy is clean and sustainable. At a depth of about 4 kilometers below the surface water gets converted in to steam, while further down few kilometers the temperatures are as high as 1200^{O}C. At certain locations below the surface, the rock is in molten form, which heats up the water present in the underground reservoirs. This hot water vents out in the form of hot springs or geysers. The water temperature ranges in such reservoirs from below 100 ^{O}C in hot water fields, temperature exceeding 100 ^{O}C with small quantity of steam in wet steam fields to dry saturated or slightly superheated steam in vapor dominated fields. In absence of water, where hot dry rocks (HDR) reservoirs are available, the rocks are artificially fractured and water is injected in to them to get steam.
The hot water or steam available from all above sources can be utilized to generate power, space conditioning, district heating, agricultural drying and industrial applications.
This unit covers geothermal resources and its utilization.

6.3.3.1.2 Unit's Objectives:

6.3.3.1.2.1: Evaluation: Estimate: To be able to estimate the energy content of a given geyser geothermal site at a given temperature and volumetric specific heat.
6.3.3.1.2.2: Evaluation: Estimate: To be able to estimate the useful heat content of a given dry rock geothermal site of given depth and temperature gradient.
6.3.3.1.2.3: Evaluation: Estimate: To be able to estimate the useful heat content of a given aquifer geothermal site of given depth, thickness, porosity, specific heat capacity and temperature gradient.

6.3.3.2 Unit: Geothermal Power Generation and Heat Pump

6.3.3.2.1 Unit's Summary :

Geothermal power plants uses energy available at higher temperature in earth's crust to generate electricity. It is a natural and clean source of energy. The hot water or steam available from hot springs or geysers, hot water fields, wet steam fields, and vapor dominated geothermal sources can be utilized to generate power. In case of hot dry rocks (HDR) reservoirs, the rocks are artificially fractured and water is injected in to them to get steam. The steam or flashed steam from these sources is fed to thermal power plant operating on Rankine cycle to generate electricity. The electricity can be generated from liquid dominated sources using flashed steam power plants or binary cycle power plants. From vapor dominated power plants generated power with steam extracted from vapor dominated sources. Geothermal fossil hybrid power plants utilizes low temperature geothermal in conventional fossil fuel based power plants.
Geothermal heat pumps (GHP) uses geothermal energy for space heating or cooling. During winter, the space is heated by transferring heat from warmer underground using water in the pipes buried underground. During summer, the space is cooled by transferring heat to cooler underground using water in the buried underground pipes.

This unit covers geothermal power plants and heat pumps.

6.3.3.2.2 Unit's Objectives:

6.3.3.2.2.1: Evaluation: Evaluate: To be able to evaluate the plant efficiency of binary cycle geothermal power plant operating on Rankine cycle for a given turbine inlet condition, power generated and condenser pressure.
6.3.3.2.2.2: Comprehension: Explain: To be able to explain with a neat sketch the given type of geothermal power plant.
6.3.3.2.2.3: Comprehension: Explain: To be able to explain with a neat sketch the given type of geothermal heat pump.

Module learning Strategy for Self Learning:

SN	Unit	Reference
1	Geothermal Resources and their Utilization	• **Book:** Tiwari G.N.; Ghosal M.K., "Renewable energy resources: Basic Principles and Applications", Narosa Publishing house, New Delhi. Chapter 8, Page no: 409 to 434. • **Book:** D.P. Kothari, K. C. Singal, R. Ranjan. "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt Ltd, New Delhi. Chapter 10, Page no: 230 to 245. • **Web link:** Geothermal Electricity and Combined Heat & Power(as accessed on 5th December 2016). • **Web link:** Geothermal 101: Basics of Geothermal Energy (as accessed on 5th December 2016).
2	Geothermal Power Generation and Heat Pump	• **Book:** Tiwari G.N.; Ghosal M.K., "Renewable energy resources: Basic Principles and Applications",Narosa Publishing house, New Delhi. Chapter 8, Page no: 434 to 453. • **Book:** D.P. Kothari, K. C. Singal, R. Ranjan. "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt Ltd, New Delhi. Chapter 10, Page no: 230 to 245. • **Web link:** Geothermal Electricity and Combined Heat & Power(as accessed on 5th December 2016). • **Web link:** Geothermal 101: Basics of Geothermal Energy (as accessed on 5th December 2016).

6.4 Module: Ocean Energy Technologies

6.4.1 Module Overview:

Oceans covers about two third of surface of the earth. Directly or indirectly it stores enormous amount energy, majority of which is solar energy. It contains energy in the form of tidal energy, wave energy, and thermal energy as temperature gradient. The potential is so high that it exceeds present world's energy

requirement.

Tidal energy is due to tides occurring in oceans as a result of gravitational pulls of the moon and the sun. Ocean's surface level changes during high tide and low tide near the shores. By constructing a dam/barrage near the shore across an estuary or creek, the water head is created, which is then converted into mechanical and thus electrical energy by employing turbo-generator system similar to the traditional hydroelectric power plants.
Wave energy is transfer of energy from wind to ocean's surface, while wind is due to uneven heating of surfaces receiving solar energy. The height of waves increases from the shore to farther in the ocean. This variation in height of large quantity of water in the form of waves can be harnessed into mechanical and thus electrical energy.
Ocean thermal energy is the temperature gradient between hot ocean surface due to absorption of solar energy and very cold deep ocean water. The temperature difference is about 20^{O}C between surface and deep ocean. This temperature difference between warm surface and cold deep ocean is utilized to run a thermal energy conversion plant operating on Rankine cycle.
This module covers Tidal energy, Wave energy and Ocean Thermal Energy Conversion systems.

6.4.2 Module Objectives:

6.4.2.1 Evaluation: Estimate: To be able to estimate the yearly power generated for a given type and specifications of a tidal power plant.
6.4.2.2 Analysis: Determine: To determine the power density of a wave of a given amplitude and time period.
6.4.2.3 Analysis: Determine: To determine theoretical power and the Carnot efficiency of OTEC power plant for a given flow rate and temperature difference between hot ocean surface and cold deep ocean water.

6.4.3 Module Units:

6.4.3.1 Unit: Tidal Energy

6.4.3.1.1 Unit's Summary :

About two third portion of the earth is covered by oceans, which constitutes huge mass and volume of water in the oceans. It is when subjected to the gravitational pull of the sun and moon and due the effect of the rotation of the earth results in tides in oceans. The effect of moon is 2.6 times more as compared to sun influencing tides in ocean. Tides results in periodic increase and decrease in the sea level near the shore. This occurs twice during 24 hrs and 50 minutes i.e. a lunar day, this is called as tidal cycle.
Near the shore the variation in water level due to tides can vary up to 10 meters. This difference in water level near shore between high tide and low tide can be stored as potential energy, which can be used to generate power similar to traditional hydroelectric power plants.
A dam/barrage is constructed near the shore across an estuary or creek to create water head. During high tide, the water fills in one or more basins, while during low tide the same water flows back to the ocean through hydraulic turbine generating power. If reversible turbine is used than power can be generated during filling up of basin also.
This unit covers tidal energy estimation, development of tidal power schemes , and important components

of tidal power plants.

6.4.3.1.2 Unit's Objectives:

6.4.3.1.2.1: Analysis: Calculate: To be able to calculate the range of tidal wave for a given period of tidal cycle.
6.4.3.1.2.2: Analysis: Determine: To be able to determine the average power generated for a given type and specifications of a tidal power plant.
6.4.3.1.2.3: Analysis: Determine: To be able to determine the power generated at any instant for a given type and specifications of a tidal power plant.

6.4.3.2 Unit:Wave Energy

6.4.3.2.1 Unit's Summary :

Waves in the ocean are caused by transfer of energy from wind to ocean surface. The height of waves increases as from the shore to farther in the ocean. This variation in height of large quantity of water in the form of waves can be harnessed into mechanical and thus electrical energy. The waves travels thousands of kilometers from the point its propagation. Waves contains tremendous power generation potential. As compared to wind energy wave energy is of more concentrated form. The wave energy varies in intensity but it is available round the clock, throughout the year.
Wave energy is converted into mechanical energy by principle of oscillating water column device, in which the up and down movement (oscillating) of water column forces the air though turbine. The turbine in turn coupled to generator to generate electrical energy.
Wave energy is also harnessed by using floating buoys, which when rise and fall along with wave, move the piston which is attached to it. The piston moves up and down and thus compresses fluid which in turn can drive a turbine- generator and generate power.
There is lot of research and development has taken place for harnessing wave energy. Pelamis, Oyster and many other devices have been developed recently. The major disadvantage of wave energy is, it is available in ocean. The equipments have to operate in saline environment.
This unit covers basics of wave motion, its mathematical analysis, and wave energy conversion systems.

6.4.3.2.2 Unit's Objectives:

6.4.3.2.2.1: Analysis: Determine: To determine the wave velocity, wave length and wave area for a given wave width and period.
6.4.3.2.2.2: Analysis: Determine: To determine the energy and power density of a wave of a given amplitude and time period.
6.4.3.2.2.3: Comprehension: Explain: To be able to explain advantage and disadvantages of wave energy with respect to wind and solar energy.

6.4.3.3 Unit:Ocean Thermal Energy Conversion

6.4.3.3.1 Unit's Summary :

Ocean Thermal Energy Conversion (OTEC) is a renewable energy technology which indirectly harnesses

the solar energy absorbed by the ocean surface. In the tropical region, significant amount of solar energy is absorbed and retained by the warm ocean surface while the water at about 800 to 1000m depth is quite cold. The temperature difference is about 20^{o}C between surface and deep ocean. This temperature difference between warm surface and cold deep ocean is utilized to run a thermal energy conversion plant operating on Rankine cycle.

OTEC uses low boiling point pure substance as a working fluid. The working fluid boils and converted into vapor at about 25^{o}C in boiler. These vapors then expands in the turbine generating power and then condense into condenser cooled by cooling water drawn from deep sea at about 5^{o}C. The condensate is then pumped back to the boiler. The efficiency of the cycle is entirely depends on the temperature difference between boiler and condenser. Higher the temperature difference, higher will be the efficiency. OTEC power plants have very low thermal efficiency but have huge power potential across globe.

This unit covers OTEC technology, its applications, and advantages and disadvantages.

6.4.3.3.2 Unit's Objectives:

6.4.3.3.2.1: Analysis: Determine: To determine the theoretical power from OTEC power plant for a given flow rate and temperature difference between hot ocean surface and cold deep ocean water.

6.4.3.3.2.2: Analysis: Determine: To determine the Carnot efficiency of OTEC power plant of given power generating capacity, flow rate and temperature difference between hot ocean surface and cold deep ocean water.

6.4.3.3.2.3: Comprehension: Explain: To be able to explain advantage and disadvantages of OTEC power plant as compared to fossil fuel based power plant.

Module learning Strategy for Self Learning:

SN	Unit	Reference
1	Tidal Energy	• **Book:** D.P. Kothari, K. C. Singal, R. Ranjan. "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt Ltd, New Delhi. Chapter 11, Page no: 246 to 268. • **Book:** Tiwari G.N.; Ghosal M.K., "Renewable energy resources: Basic Principles and Applications", Narosa Publishing house, New Delhi. Chapter 9, Page no: 471 to 481. • **Journal Paper**: Bedard, R., P.T. Jacobson, M. Previsic, W. Musial, and R. Varley. 2010. An overview of ocean renewable energy technologies. *Oceanography* 23(2):22–31. • **Web link:** Ocean Energy Technologies for Renewable Energy Generation (as accessed on 5th December 2016). • **Web link:** Kalpasar Project Gujarat (as accessed on 5th December 2016).
2	Wave Energy	• **Book:** D.P. Kothari, K. C. Singal, R. Ranjan. "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt Ltd, New Delhi. Chapter 11, Page no: 269 to 286. • **Book:** Tiwari G.N.; Ghosal M.K., "Renewable energy resources: Basic Principles and Applications",Narosa Publishing house, New Delhi. Chapter 9, Page no: 481 to 493.

SN	Unit	Reference
		• **Journal Paper**: Bedard, R., P.T. Jacobson, M. Previsic, W. Musial, and R. Varley. 2010. An overview of ocean renewable energy technologies. *Oceanography* 23(2):22–31. • **Web link:** Ocean Energy Technologies for Renewable Energy Generation (as accessed on 5th December 2016).
3	Ocean Thermal Energy Conversion	• **Book:** Tiwari G.N.; Ghosal M.K., "Renewable energy resources: Basic Principles and Applications",Narosa Publishing house, New Delhi. Chapter 9, Page no: 457 to 471. • **Book:** D.P. Kothari, K. C. Singal, R. Ranjan. "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt Ltd, New Delhi. Chapter 11, Page no: 287 to 292. • **Journal Paper**: Bedard, R., P.T. Jacobson, M. Previsic, W. Musial, and R. Varley. 2010. An overview of ocean renewable energy technologies. *Oceanography* 23(2):22–31. • **Web link:** Ocean Thermal Energy Conversion Technology Brief(as accessed on 5th December 2016).

6.5 Module: Solar Energy Technologies

6.5.1 Module Overview:

Solar energy is the abundant, free, most readily available, renewable and non polluting source of energy received by earth. If entirely harvested, it can fulfill over 10,000 times the current global energy requirement. It is also available indirectly in the form of wind, wave, ocean thermal, hydro, biomass, bio gas, and fossil fuels.

The solar energy can directly be harnessed in two ways; solar photovoltaic (PV) and solar thermal. Solar PV works on the principle of photovoltaic effect and convert solar energy directly in to electricity. In Solar thermal, the energy received from the sun in the form of heat is utilized. It is directly used for heating/cooling applications or it is converted into electricity by using a device called as heat engine.

Solar thermal is majorly utilized for space heating applications, drying etc using flat plate collectors or solar concentrators.

Concentrating solar power (CSP) technology uses reflectors or refractors to concentrate solar energy falling on large area on to a receiver of smaller area. Thus producing thermal energy at high temperatures depending upon the concentration ratio (ratio of aperture area to the absorber area). This high temperature thermal energy from the receiver is transferred to heat transfer fluid, which in turn drives the turbo-generator system to produce electricity. These technologies are also used in utility-scale projects for power generation and industrial process heating applications

Small CSP systems are also used for cooking, solar drying, refrigeration and air conditioning using vapor absorption refrigeration systems.

This module covers solar radiation basics. It also covers liquid flat plate collectors, solar air heaters, concentrating collectors, solar pond, solar PV and their analysis.

6.5.2 Module Objectives:

6.5.2.1 Evaluation: Evaluate: To evaluate over-all heat loss coefficient and performance in the form of its instantaneous efficiency of a liquid flat plate collector of a given dimensions, for a given location, ambient condition and time under steady state condition.
6.5.2.2 Evaluation: Evaluate: To estimate given solar air heater's collector efficiency factor and heat removal factor and evaluate its performance in terms of its instantaneous efficiency for a given location and time under steady state condition.
6.5.2.3 Evaluation: Evaluate: To evaluate over-all heat loss coefficient of a parabolic trough collector of a given dimensions and parameters, and evaluate its performance in terms of its instantaneous efficiency for a given location and time.

6.5.3 Module Units:

6.5.3.1 Unit: Solar Radiation

6.5.3.1.1 Unit's Summary :

The Sun is a source for all renewable energy sources on Earth. The solar energy falling on earth exceeds thousand times over the current energy needs of the mankind. Solar radiation is considered as an electromagnetic wave. The solar radiation of wavelength ranging from 0.25to 3 μm is of primary importance and includes most of solar radiation emitted by the sun. The earth rotates about its axis and also it rotates about the sun in elliptical orbit, this results in variation of solar radiation throughout the day and year. For prediction of solar radiation at a location, understanding of solar geometry in terms of solar angles is very much important. It helps in converting radiation flux falling on one plane to its equivalent radiation on another plane. Solar radiation can be measured using instruments like pyranometer and pyrheliometer. In absence of availability of solar radiation measurements, empirical equations established by many researchers are used for predicting solar radiation at a given location.
This unit covers solar radiation basics, its measurements, solar radiation geometry and empirical equations for predicting availability of solar radiation

6.5.3.1.2 Unit's Objectives:

6.5.3.1.2.1: Evaluation: Estimate: To be able to estimate the number of sunshine hours for for a particular location at a given time of the year.
6.5.3.1.2.2: Evaluation: Estimate: To be able to estimate the average daily global solar radiation on a horizontal surface at a particular location at a given time.
6.5.3.1.2.3: Evaluation: Estimate: To be able to estimate the diffuse, beam, total solar radiation and reflected radiation on a given surface at a particular location at a given time.

6.5.3.2 Unit: Liquid Flat Plate Collectors -1

6.5.3.2.1 Unit's Summary :

A solar collector is a device which receives solar radiation and convert it into low grade energy i.e. heat.

This solar energy can be used for many medium temperature applications requirements i.e. between 60 to 100^{o}C. A device which receives solar energy and transform it into thermal energy i.e. heat using water as a working fluid is known as a liquid flat-plate collector. They use diffuse as well as beam radiation, no tracking requirement, simple in construction and require little maintenance. Their major applications are in solar water heating, building heating, air conditioning, and industrial process heat. Their detailed performance analysis is of importance owing to their importance in thermal processes.
This unit covers liquid flat plate collector and its performance analysis.

6.5.3.2.2 Unit's Objectives:

6.5.3.2.2.1: Analysis: Analyze: To draw and analyze the thermal resistance network of a given flat plate collector along with energy exchange.
6.5.3.2.2.2: Evaluation: Estimate: To estimate over-all heat loss coefficient of a liquid flat plate collector of a given dimensions and ambient condition.
6.5.3.2.2.3: Evaluation: Evaluate: To evaluate performance of a liquid flat plate collector of a given dimensions and ambient condition in terms of its instantaneous efficiency for a given location and time under steady state condition.

6.5.3.3 Unit: Liquid Flat Plate Collectors - 2

6.5.3.3.1 Unit's Summary :

The main purpose of any solar collector is to collect maximum possible solar energy economically. The liquid flat plate collectors are widely used for low and medium temperature applications. These collectors should be efficient, robust and durable under adverse conditions of weather, dust deposition, hardness of heat transfer liquid etc. It is important know the effect of parameters like selective surfaces, number of covers, spacing between covers, fluid inlet temperature, dust on covers etc. on their performance. These collectors are fixed type collector with no sun tracking. In order to get best annual performance without tracking and seasonal adjustments, the collector should be titled at optimum tilt. Liquid flat plate collectors have been built with modified absorber designs in order to enhance the heat transfer rate to the heat transfer liquid medium.
Liquid flat plate collectors are tested using standard test procedure proposed National Bureau of Standards and American
Society of Heating, Refrigeration, and Air conditioning Engineers (ASHRAE).
This unit covers effect of various parameters on the performance of liquid flat plate collector, its transient analysis and testing procedure.

6.5.3.3.2 Unit's Objectives:

6.5.3.3.2.1: Analysis: Determine: To determine the optimum tilt for a given flat plate collector at given location and condition.
6.5.3.3.2.2: Evaluation: Estimate: To estimate the time required to reach operating temperature of a liquid flat plate collector of a given dimensions and ambient condition using transient analysis.
6.5.3.3.2.3: Analysis: Diagram: To explain with the help of schematic diagram the testing procedure of liquid

flat plate collector.

6.5.3.4 Unit: Solar Air Heaters

6.5.3.4.1 Unit's Summary :

Solar air heater is a flat plate collector with air as a working fluid. Use of air eliminates a need of an heat exchanger which is required in case of liquid flat plate collector, where heat is first transferred to liquid in collector and then is transferred to air in heat exchanger. This type of collectors producing heated air are used for drying agricultural produce, industrial purpose and space heating. The hot air from the collector is either directly used for space heating or conditioned air for buildings, for process heating, or sent to a storage medium for sensible heat storage like rock bed. In solar drying, the pre-heated air from the collector is passed through the product. The product may be directly exposed to solar radiation or a combination of hot air and exposure to solar radiation is used.
The basic components of a solar air heater system include transparent cover, absorber casing, insulation, and air as heat transfer medium. These may be with or without fan/blower. These collectors are simple in design and need very little maintenance, also since air is heat transfer medium, so have no problems of freezing at below $0^{o}C$ operations. These are less efficient as compared to liquid flat plate collector owing to lower heat transfer coefficient of air. So in order to improve their performance fins on absorber or corrugated absorber etc. are used.
This unit covers solar air heaters types, performance analysis of a conventional air heater and its testing procedures.

6.5.3.4.2 Unit's Objectives:

6.5.3.4.2.1: Evaluation: Estimate: To estimate overall heat loss coefficient for a solar air heater of a given condition.
6.5.3.4.2.2: Evaluation: Estimate: To estimate collector efficiency factor and heat removal factor of a solar air heater of a given dimensions and ambient condition.
6.5.3.4.2.3: Evaluation: Estimate: To estimate performance of a solar air heater of a given dimensions and ambient condition in terms of its instantaneous efficiency under a steady state condition.

6.5.3.5 Unit: Concentrating Collectors - 1

6.5.3.5.1 Unit's Summary :

Flat plate collectors are useful for heating fluids around $100^{o}C$. For achieving higher temperatures a large amount of solar radiation is concentrated on a relatively smaller area. This is achieved by using reflectors or refractors to concentrate sunlight onto a small area called as absorber, thus produce heat at high temperatures. This thermal energy can be used to produce steam, which in turn can drive turbo-generators to produce electricity. The receivers can be convex, flat, cylindrical or concave and can be covered with glazing or uncovered. The ratio of aperture area to the absorber area is called as concentration ratio (CR). It is unity for flat plat collector and can be of the order of 10,000. Higher CR means higher the temperature at which energy can be delivered.

Concentrating collectors can further be classified into imaging type and non-imaging type. The imaging type collectors are the collectors where Sun's image is focused at the receiver. The parabolic trough collector, Linear Fresnel reflector (LFR), parabolic dish, and central tower receiver are imaging type collectors.

The parabolic trough collector (PTC) is also referred to as cylindrical parabolic collector or a linear parabolic collector, is consists of a parabolic shaped sheet of reflective material as concentrator, a metallic absorber tube placed along the focal line with heat transfer fluid flowing through it. The absorber tube is covered with a glass tube. The annulus between glass tube and absorber tube may be evacuated or non evacuated in order to reduce its heat losses. Reflector may be made of curved silvered glass, or anodized aluminum sheets, or aluminized Mylar. The absorber tube is usually made up of copper or mild steel (low carbon) and usually coated with heat resistant black paint coating. PTC needs single axis tracking. It is orientated either in an east–west direction with north-south sun tracking, or orientated in a north–south direction with east–west sun tracking. PTCs can be used effectively for thermal applications in temperatures between 50 ^{O}C and 400 ^{O}C. They are used in extensively in process heat applications and solar thermal power generation systems.

This unit covers introduction and classifications of concentrating collectors. It also covers PTC and its performance analysis.

6.5.3.5.2 Unit's Objectives:

6.5.3.5.2.1: Comprehension: Explain: To explain tracking modes used for concentrating collectors like east-west horizontal, north-south horizontal, and northsouth inclined etc.

6.5.3.5.2.2: Evaluation: Estimate: To estimate heat removal factor for a cylindrical parabolic collector of a given dimensions and ambient condition.

6.5.3.5.2.3: Evaluation: Estimate: To estimate useful heat gain of a cylindrical parabolic collector of a given dimensions and ambient condition.

6.5.3.6 Unit:Concentrating Collectors - 2

6.5.3.6.1 Unit's Summary :

In a concentrating collector, radiation flux is focused on the absorber. The concentration of radiation flux can be increased multifold by using concentrators. Concentrating collectors can further be classified into imaging type and non- imaging type, whether the collectors focuses the Sun's image on the receiver or just diverts it. Imaging collectors need continuous sun tracking. Concentrators can be classified according to refractor or reflector type, according to the shape i.e. cylindrical or surfaces of revolution, and they can be continuous or segmented. The receivers can be convex, flat, cylindrical or concave and can be covered with glazing or uncovered.

Compound parabolic collector or concentrator (CPC) is a non-imaging type collector with large acceptance angle and needs only intermittent tracking. It gives maximum permissible concentration under thermodynamic limit for a particular acceptance angle. It can be used up to concentration ratio (CR) of 6 in non-tracking mode as with increase in CR increases the area of reflecting surface.

A parabolic dish collector is a point focus collector and needs two axis tracking. It's shape is like a parabolic dish with mirror like reflectors and the receiver at its focal point. The receiver receives the solar energy and

transfers it to the heat transfer fluid in the absorber. The thermal energy thus received may either be used for thermal applications or is supplied to a heat engine like Stirling engine, which is coupled to generator to generate electricity. The temperature at the receiver can reach above 1500°C and are highly efficient in small power capacity and have CR in the range of 600-2000.
The central receiver collector consists of arrays of large mirrors, also called as heliostats, fixed to supporting frame with dual axis tracking, reflecting solar radiation on a central stationary receiver situated at the top of the tower. The thermal energy is transferred to the heat transfer fluid, which is sent to the ground where it is used to produce steam to run the Rankine cycle based power plant. The advantage of such collector is there is no need to carry working fluid over large distance hence reduced heat losses.
This unit covers CPC, parabolic dish collector and central receiver collector systems. It also covers the performance analysis of CPC and central receiver collector systems.

6.5.3.6.2 Unit's Objectives:

6.5.3.6.2.1: Evaluation: Estimate: To estimate minimum acceptance angle required, concentration ratio and orientation of compound parabolic collector for a given location and date.
6.5.3.6.2.2: Evaluation: Evaluate: To evaluate performance of a compound parabolic collector of a given specifications and ambient condition in terms of its instantaneous efficiency for a given location and time.
6.5.3.6.2.3: Analysis: Determine: To determine the size of image formed by the mirror at the receiver, the area of absorber and concentration ratio for a given type of mirror of central tower receiver system and analyze the results.

6.5.3.7 Unit: Solar Pond

6.5.3.7.1 Unit's Summary :

Solar energy is available in abundance on earth. One of the many ways of available of tapping it is by using solar pond. It works on the simple principle that when the water is heated in a pond its density decreases and it rises up and cold water from the top goes down due to density difference. The hot water after reaching the top and loses heat to the ambient and cools down. This process is called as natural convection. The net effect is the water and reaches the top but loses the heat into the atmosphere. The net result is the water remains at ambient temperature. The solar pond restricts this convection current by making the bottom layer of the pond saline by dissolving salt in it and maintaining concentration gradient, with salinity maximum in the bottom layer. Such ponds are termed as salt-gradient solar ponds.
A solar pond consists of three zones. The top zone is the surface convective zone, which has low and uniform salt concentration and is at fairly uniform temperature near to ambient temperature. The middle zone is non convective zone. It is much thicker as compared to top zone and the salt concentration and temperature in this zone increases with increase in depth. This zone acts as a insulating layer between bottom zone and top zone and decreases heat losses from bottom zone to top zone. The bottom zone is lower convective zone, has high salt concentration. Both the temperature and concentration are uniform in this zone. It can reach to maximum value of 85 to 95^{O}C in summer. It is the zone which collects and stores thermal energy.
Solar ponds can be use for water desalination, process heating, drying and power generation using organic Rankine cycle.

This unit covers the description and performance analysis of solar pond.

6.5.3.7.2 Unit's Objectives:

6.5.3.7.2.1: Knowledge: Describe: To be able to describe with neat sketch the working of solar pond showing all the three zones.
6.5.3.7.2.2: Analysis: Determine: To determine annual collection efficiency of a given solar pond for a given energy requirement for a given location and ambient conditions.

6.5.3.8 Unit: Solar Photovoltaic system

6.5.3.8.1 Unit's Summary :

Solar Photovoltaic (SPV) system converts solar energy directly into electricity (direct current) without any intermediate process using the phenomenon of photovoltaic effect. When the solar energy is absorbed by solar cell, it knocks off the electrons from their atoms. These free electrons flow through the material to produce electricity. The device which is used for direct conversion of solar energy into electricity using photovoltaic effect is called as solar cell or photovoltaic cell. These are small in size, combination of these small solar cell is called as a module and combination of modules is called as an array.
Electricity generated using SPV system can be directly being used for running appliance using charge controller and inverter. Charge controller regulates the voltage and current from SPV system while inverter converts direct current into alternating current.
SPV is a commercially proven technology and is widely used for power generation. It is being used for street lighting, home lighting, water pumping and also as power plants supplying power to the grid. They are also being used in hybrid mode with diesel generator, wind turbines etc.
This unit covers basics of SPV systems, materials for solar cells and applications of SPV systems.

6.5.3.8.2 Unit's Objectives:

6.5.3.8.2.1: Comprehension: Explain: To be able to explain the current voltage characteristics of a solar cell.
6.5.3.8.2.2: Comprehension: Explain: To be able to explain the limits to cell efficiency.
6.5.3.8.2.3: Analysis: Determine: To determine the maximum power, fill factor and electrical efficiency of a given solar cell under specified conditions.

Module learning Strategy for Self Learning:

SN	Unit	Reference
1	Solar Radiation	• **Book:** S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 3, Page no: 61 to 95. • **Web link:NPTEL:** Solar Energy Technology, (as accessed on 15th October 2016) • **Web link:NPTEL:** Sun - Earth Geometry, Terminologies(as accessed on 15th October 2016)

SN	Unit	Reference
2	Liquid Flat Plate Collectors -1	• **Book:** S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 4, Page no: 99 to 132. • **Journal Paper:** S. A. Kalogirou, Solar thermal collectors and applications, Progress in Energy and Combustion Science, Volume 30, Issue 3, 2004, Pages 231-295, ISSN 0360-1285, http://dx.doi.org/10.1016/j.pecs.2004.02.001. • **Web link:NPTEL:** Solar Energy Technology, (as accessed on 15th October 2016) • **Web link:NPTEL:** Theory of Flat Plate Collectors - Liquid Based 1, 2, 3, 4
3	Liquid Flat Plate Collectors - 2	• **Book:** S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 4, Page no: 133 to 166. • **Journal Paper:** S. A. Kalogirou, Solar thermal collectors and applications, Progress in Energy and Combustion Science, Volume 30, Issue 3, 2004, Pages 231-295, ISSN 0360-1285, http://dx.doi.org/10.1016/j.pecs.2004.02.001. • **Web link: NPTEL:** Solar Energy Technology, (as accessed on 15th October 2016) • **Web link:NPTEL:** Theory of Flat Plate Collectors - Liquid Based 1, 2, 3, 4
4	Solar Air Heaters	• **Book:** S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 5, Page no: 171 to 195. • **Web link: NPTEL:** Solar Energy Technology, (as accessed on 15th October 2016) • **Web link: NPTEL:** Theory of Air Based Solar Flat Plate Collectors 1,2,3, (as accessed on 15th October 2016) • **Journal Paper:** Abhishek Saxena, Varun, A.A. El-Sebaii, A thermodynamic review of solar air heaters, Renewable and Sustainable Energy Reviews, Volume 43, March 2015, Pages 863-890, ISSN 1364-0321, http://dx.doi.org/10.1016/j.rser.2014.11.059. • **Journal Paper:** S. A. Kalogirou, Solar thermal collectors and applications, Progress in Energy and Combustion Science, Volume 30, Issue 3, 2004, Pages 231-295, ISSN 0360-1285, http://dx.doi.org/10.1016/j.pecs.2004.02.001.
5	Concentrating Collectors - 1	• **Book:** S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 6, Page no: 197 to 224. • **Web link: NPTEL:** Solar Energy Technology, (as accessed on 15th October 2016) • **Web link: NPTEL:** Concentrating Collectors 1, 2, 3, 4(as accessed on 15th October 2016)

SN	Unit	Reference
		• **Journal Paper:** S. A. Kalogirou, Solar thermal collectors and applications, Progress in Energy and Combustion Science, Volume 30, Issue 3, 2004, Pages 231-295, ISSN 0360-1285, http://dx.doi.org/10.1016/j.pecs.2004.02.001.
6	Concentrating Collectors - 2	• **Book:** S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 6, Page no: 225 to 254. • **Web link: NPTEL:** Solar Energy Technology, (as accessed on 15th October 2016) • **Web link: NPTEL:** Concentrating Collectors 1, 2, 3, 4 (as accessed on 15th October 2016) • **Journal Paper:** S. A. Kalogirou, Solar thermal collectors and applications, Progress in Energy and Combustion Science, Volume 30, Issue 3, 2004, Pages 231-295, ISSN 0360-1285, http://dx.doi.org/10.1016/j.pecs.2004.02.001.
7	Solar Pond	• **Book:** S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 8, Page no: 294 to 323.
8	Solar Photovoltaic system	• **Book:** D.P. Kothari, K. C. Singal, R. Ranjan. "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt Ltd, New Delhi. Chapter 6, Page no: 122 to 146. • **Book:** S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill Publishing Company Limited, New Delhi. Chapter 10, Page no: 339 to 353. • **Web link: NREL:** Basic Photovoltaic Principles and Methods - NREL (as accessed on 15th October 2016) • **Web link: NPTEL:** Solar Cells, (as accessed on 15th October 2016)

6.6 Module: Wind Energy Technologies

6.6.1 Module Overview:

Wind is a form of solar energy, caused by uneven heating of the earth surfaces and atmosphere by the sun and also due to rotation of the earth. This wind energy is being harness for sailing of ships, water pumping etc by human being since ancient times. This energy is converted into mechanical energy by using wind turbine, which when coupled to generator produces electricity.

Wind turbines are mainly classified according to axis of rotation, i.e. horizontal axis and vertical axis. They are also classified according to forces acting like lift and drag, and according to rotor speed as constant speed or variable speed. Wind turbine blades are designed using aerodynamics principles.

Wind energy conversion system consists of rotor blades, rotor hub and shaft assembly, transmission system consisting of gear box for increasing shaft speed to that of generator speed and braking system, electric generator, yaw mechanism and control system. The entire transmission, generator and control

system is kept in housing called as nacelle. The nacelle is placed on the tower.
Windmills are being used since ages for water pumping in high windy regions. It is also being used worldwide for power generation both on ground and off-shore. It is one of the highest contributor of renewable power generation globally as well as in India.
This module covers wind energy technologies and their analysis.

6.6.2 Module Objectives:

6.6.2.1 Analysis: Determine: To determine the maximum power density, torque and maximum axial thrust for a given wind turbine at a given condition.
6.6.2.2 Evaluation: Evaluate: To determine the efficiency of wind turbine, horizontal force exerted on the turbine tower for a given wind turbine under a given operating conditions and evaluate its performance under variable wind velocity conditions.
6.6.2.3 Evaluation: Estimate: To be able to estimate the power density, maximum possible power density, and actual power density of air, as well as power output from a given wind turbine at different altitudes.

6.6.3 Module Units:

6.6.3.1 Unit: Wind Energy - 1

6.6.3.1.1 Unit's Summary :

Wind energy is a form of solar energy caused due to uneven heating of earth surface. Of the total solar energy that reaches the earth surface, about 2 percent is transformed into wind energy. Since ancient times wind energy is being exploited by the mankind in the form of sailing of ships, water pumping etc. Wind energy is converted into mechanical energy by using wind turbine, which when coupled to generator produces electricity.
Wind turbines are classified according to forces acting as lift and drag type, according to axis of rotation as horizontal and vertical axis type, and according to rotor of variable speed or constant speed. Wind turbine blades are designed using aerodynamics principles. Understanding of lift and drag forces and wind energy extraction by wind turbine is important for the analysis of wind turbine.
This unit covers historical developments, classification, aerodynamics and energy extraction of wind turbines.

6.6.3.1.2 Unit's Objectives:

6.6.3.1.2.1: Analysis: Differentiate: To be able to differentiate wind turbines on the basis of forces acting on blades, axis of rotation, types of rotor.
6.6.3.1.2.2: Analysis: Determine: To determine the condition of maximum theoretical efficiency of a wind turbine for a given condition.
6.6.3.1.2.3: Analysis: Determine: To determine the maximum power density for a given wind stream at a given condition.

6.6.3.2 Unit: Wind Energy - 2

6.6.3.2.1 Unit's Summary :

The coefficient of power or maximum theoretical efficiency of wind turbine is the ratio of power output from the wind turbine to the total power available in wind. Wind turbine extracts energy from wind by reducing its velocity. In order to have 100% efficient wind turbine, the turbine should reduce down the wind velocity to zero, for this turbine should be a solid disc, but such system will not work.
A German aerodynamicist, Albert Betz , in 1919, derived the condition of maximum coefficient of power by applying conservation of mass and conservation of energy principles to the wind turbine. He mathematically proved that a horizontal axis wind turbine can extract maximum of 59.3% of mechanical energy from the kinetic energy of the wind. This is known as the Betz Criterion or Betz Limit.
The ratio of speed of tip of wind turbine blade to that of free wind speed is called as tip speed ratio. it is extremely important factor in wind turbine design. Too low value of tip speed will reduce down the efficiency and too high value will result in wind turbine acting as a solid wall. So, wind turbines should be designed for optimal tip speed ratio.
The performance of wind turbine is characterized by the way in which thrust, torque and power varies with the wind speed. These characteristics are called as operational characteristics.
This unit covers the Betz limit, operational characteristics and blade element theory of wind turbine.

6.6.3.2.2 Unit's Objectives:

6.6.3.2.2.1: Analysis: Determine: To determine coefficient of power for a given wind turbine under specified conditions like wind velocity, power output etc.
6.6.3.2.2.2: Analysis: Determine: To determine the condition for maximum axial force coefficient (CF) for a wind turbine using an interference factor.
6.6.3.2.2.3: Evaluation: Evaluate: To determine the efficiency of wind turbine, horizontal force exerted on the turbine tower for a given wind turbine under a given operating conditions and evaluate its performance under variable wind velocity conditions.

6.6.3.3 Unit: Wind Energy - 3

6.6.3.3.1 Unit's Summary :

For optimum wind turbine design, accurate visualization of variation in wind speed is important. Weibull probability density function can describe mathematically wind regime. In order to have accurate estimates, meteorological measurements on hourly basis of parameters like temperature, wind speed, wind direction, rainfall etc. are done at the proposed site. From the recorded data, variation in speed of wind and variation in direction is plotted for a month, season, or yearly average basis. Such plots are called as wind rose diagrams. Variation in speed and frequency of wind is important in wind turbine plant layout design. A site with uniform wind rose is a suitable for wind turbine power plant.
Wind energy conversion system consists of mainly rotor (rotor blades, rotor hub and shaft), transmission system consisting of gear box and braking system, electric generator, yaw mechanism and control system, all these are kept in housing called as nacelle, and tower on which nacelle is placed. Rotors generally rotates at ow rpms, the transmission system with gear box arrangement increase the rpm to synchronous speed of generator. Yaw control keep the rotor oriented in the wind direction.

Wind energy systems can be used in standalone mode with battery storage for a domestic power supply. Also windmill water pumping system is used for pumping water, particularly in the areas where sufficient wind speeds are available during crop cultivation period. They are even coupled with drip irrigation system for optimal use of water. Wind energy systems are also coupled with diesel generator as back up where intermitted wind is available. Wind turbine generators of capacity ranging from 250 kW to 3 MW or higher are connected to grid. Such systems are installed where the wind sites are far off from the load centers and grid connectivity is available.
This unit covers assessment of wind energy site, wind energy conversion system, applications, advantages and disadvantages.

6.6.3.3.2 Unit's Objectives:

6.6.3.3.2.1: Evaluation: Estimate: To be able to estimate the wind speed at a given height for a given terrain and atmospheric condition.
6.6.3.3.2.2: Synthesis: Design: To be able to design wind turbine rotor radius for a given turbine and power coefficient under given atmospheric condition for pumping water up to a given height and at a given flow rate.
6.6.3.3.2.3: Evaluation: Estimate: To be able to estimate the power generated by the given wind turbine at a given altitude for the change in wind speeds.

Module learning Strategy for Self Learning:

SN	Unit	Reference
1	Wind Energy - 1	• **Book:** Tiwari G.N.; Ghosal M.K., "Renewable energy resources: Basic Principles and Applications",Narosa Publishing house, New Delhi. Chapter 7, Page no: 338 to 356. • **Book:** D.P. Kothari, K. C. Singal, R. Ranjan. "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt Ltd, New Delhi. Chapter 7, Page no: 147 to 158. • **Web link: NPTEL:** Wind Energy 1, 2, 3, 4, 5, 6 (as accessed on 15th October 2016).
2	Wind Energy - 2	• **Book:** Tiwari G.N.; Ghosal M.K., "Renewable energy resources: Basic Principles and Applications",Narosa Publishing house, New Delhi. Chapter 7, Page no: 356 to 374. • **Book:** D.P. Kothari, K. C. Singal, R. Ranjan. "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt Ltd, New Delhi. Chapter 7, Page no: 158 to 171. • **Web link: NPTEL:** Wind Energy 1, 2, 3, 4, 5, 6 (as accessed on 15th October 2016).
3	Wind Energy - 3	• **Book:** Tiwari G.N.; Ghosal M.K., "Renewable energy resources: Basic Principles and Applications",Narosa Publishing house, New Delhi. Chapter 7, Page no: 375 to 393. • **Book:** D.P. Kothari, K. C. Singal, R. Ranjan. "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt Ltd, New Delhi. Chapter 7, Page no: 171 to 185

SN	Unit	Reference
		• **Web link: NPTEL:** Wind Energy 1, 2, 3, 4, 5, 6 (as accessed on 15th October 2016).

6.7 Module: Biomass and its Conversion Technologies

6.7.1 Module Overview:

Biomass is a term used to describe all biologically produced matter and it is the name given to all earth's living matter. The chemical energy contained in the biomass is derived from solar energy using the process of photosynthesis. This is the process by which plants take in carbon dioxide and water from their surroundings and, using the energy from sunlight, convert them into sugars, starches, cellulose, lignin, etc. The stored energy in the plants and animals (that eat the plants and other animals), or the waste that they produce is called biomass energy or bioenergy. Bioenergy is arguably the one truly renewable energy resource, in that each new crop or harvest represents a partial renewal of its resource base, which itself is subject to constant depletion through its use as a fuel or feedstock.
Conventionally biomass was used in a similar way to fossil fuels, by burning it at a constant rate in a boiler furnace to heat water for producing steam. For efficiently utilizing the biomass energy, it has to be converted into a suitable fuel. The conversion technologies for utilizing biomass can be separated into three basic categories: Thermo-chemical processes and Biochemical processes. This module covers the biomass characteristics, biomass potential, thermo- chemical conversion processes and biochemical processes.

6.7.2 Module Objectives:

6.7.2.1 Analysis: Examine: To examine the availability of biomass resources and find appropriate conversion technology for waste utilization
6.7.2.2 Evaluation: Evaluate: To evaluate the applicability of biomass conversion methods such as pyrolysis, gasification, carbonization, digestion, fermentation for biomasses such as food waste, agricultural residue, municipal solid waste, wood waste, and saw dust.
6.7.2.3 Evaluation: Evaluate: To evaluate the performance of the biomass conversion methods such as pyrolysis, gasification, carbonization, digestion, fermentation in terms of efficiency.

6.7.3 Module Units:

6.7.3.1 Unit: Biomass: potential, sources and characteristics

6.7.3.1.1 Unit's Summary :

Biomass is a general term for material derived from growing plants or from animal manure (which is effectively a processed form of plant material). Biomass energy is derived from the plant sources, such as wood from natural forests, waste from agricultural and forestry processes and industrial, human or animal wastes. The stored energy in the plants and animals (that eat the plants and other animals), or the waste that they produce is called biomass energy or bioenergy. It is a natural process that the entire biomass ultimately decomposes to its molecules with the release of heat. And the combustion of biomass

imitates the natural process. So the energy obtained from biomass is a form of renewable energy and it does not add carbon dioxide to the environment in contrast to the fossil fuels. Biomass majorly consists of cellulose, hemicellulose and lignin. It's main characteristics can be described by three analysis: proximate analysis, ultimate analysis, and chemical analysis.

6.7.3.1.2 Unit's Objectives:

6.7.3.1.2.1: Knowledge: Identify: To identify biomass resources and its potential for a given region
6.7.3.1.2.2: Analysis: Compare: To compare the biomasses based on its proximate and ultimate analysis
6.7.3.1.2.3: Evaluation: Evaluate: To evaluate the biomass as a potential precursor for conversion technologies based on its proximate and chemical analysis

6.7.3.2 Unit: Thermo-chemical Conversion of biomass: Introduction

6.7.3.2.1 Unit's Summary :

This unit introduces the basics of all thermo-chemical conversion technologies namely pyrolysis, liquefaction, and gasification. Pyrolysis involves heating of biomass in the limited supply/absence of air, which produces mainly three products namely, gas, char, and liquid. Liquefaction is also a process involving the heating of biomass in absence of oxygen. However, it is performed at lower temperature and in presence of catalysts. Gasification is essentially a conversion process of biomass/coal to gaseous fuel. The major advantage of the process is the increase of the heating value of the fuel by removing the noncombustible components.

6.7.3.2.2 Unit's Objectives:

6.7.3.2.2.1: Evaluation: Evaluate: To evaluate the thermal stability of biomass constituents: cellulose, hemi cellulose and lignin based on thermal degradation characteristics
6.7.3.2.2.2: Analysis: Analyze: To analyze the comparative performance of the pyrolysis processes (like slow pyrolysis, fast pyrolysis and flash pyrolysis) in terms of product yields

6.7.3.3 Unit: Gasification: Theory

6.7.3.3.1 Unit's Summary :

The understanding of the gasification process helps one to design and operation of a gasifier. It also improves the understanding of the influence of the operating parameters on the performance of the plant. This unit focuses on the basics of the gasification process. The operating conditions, reactions, materials and energy exchange occurring in the developed zones such as drying, pyrolysis, reduction and combustion in the gasification process are discussed.

6.7.3.3.2 Unit's Objectives:

6.7.3.3.2.1: Application: Prepare: To prepare the schematic diagram showing the material and energy exchange amongst developed zones such as drying, pyrolysis, reduction and combustion in the gasification

process
6.7.3.3.2.2: Analysis: Compare: To compare the operating conditions and reactions occurring in the developed zones such as drying, pyrolysis, reduction and combustion in the gasification process

6.7.3.4 Unit: Types of gasifier and performance evaluation

6.7.3.4.1 Unit's Summary :

Gasifiers are generally classified according to the contacting pattern of the fuel with entering air, type of bed, type of fuels used and direction of air/gas movement. The most important classification is based on the type of beds i.e. fixed bed and fluidized bed. Under the fixed bed gasifier classification, further they can be sub classified into updraft, downdraft and cross draft gasifiers. This unit discusses the comparison of various types of gasifiers in terms of operating conditions and advantages/disadvantages. The gasifier performance can be evaluated in terms of equivalence ratio, producer gas generated per kg of biomass consumed, gas composition & its calorific value and cold gas efficiency. This unit introduces the steps involved in calculation of performance parameters.

6.7.3.4.2 Unit's Objectives:

6.7.3.4.2.1: Analysis: Compare: To compare the operation of fixed bed gasifier with fluidized one in terms of operating conditions and performance
6.7.3.4.2.2: Analysis: Compare: To compare the updraft and downdraft gasifier in terms of functioning, operating conditions, and working principles
6.7.3.4.2.3: Evaluation: Evaluate: To evaluate the performance of a gasifier in terms of equivalence ratio, producer gas generated per kg of biomass consumed, gas composition & its calorific value and cold gas efficiency

6.7.3.5 Unit:Biochemical conversion of biomass: Digestion

6.7.3.5.1 Unit's Summary :

Biochemical conversion of biomass utilizes bacteria, microorganisms and enzymes to breakdown biomass into gaseous or liquid compounds, such as biogas or bioethanol. Anaerobic digestion (or biomethanation) and fermentation are considered as the most popular biochemical technologies. This chapter deals with the anaerobic digestion. It is a series of chemical reactions in an oxygen depleted environment. In this process, organic material is decomposed through the metabolic pathways of naturally occurring microorganisms.

6.7.3.5.2 Unit's Objectives:

6.7.3.5.2.1: Application: Prepare: To prepare the biomethanation process block diagram covering intermediate steps and reactions and microorganisms involved in each step
6.7.3.5.2.2: Analysis: Analyze: To analyze the effects of factors such as pH, Carbon to Nitrogen ratio, temperature, loading rate, hydraulic retention time on the yield of bio gas
6.7.3.5.2.3: Comprehension: Classify: To classify bio gas digester in floating dome vs fixed dome, low rate vs

high rate, and first vs second vs third generation anaerobic reactors
6.7.3.5.2.4: Synthesis: Design: To design the biogas digester system by calculating the volume and available power from the digester provided number of cow, retention period, temperature of fermentation, burner efficiency and methane proportions

6.7.3.6 Unit: Biochemical conversion of biomass: Fermentation

6.7.3.6.1 Unit's Summary :

Biochemical conversion of biomass utilizes bacteria, microorganisms and enzymes to breakdown biomass into gaseous or liquid compounds, such as biogas or bioethanol. Anaerobic digestion (or biomethanation) and fermentation are considered as the most popular biochemical technologies. This chapter deals with the fermentation. Fermentation, a metabolic process, converts sugar to acids, gases, or alcohol and releases energy in an anaerobic medium. Fermentation is also referred to the bulk growth of microorganisms on a growth medium, often with the goal of producing a specific chemical product. In the present context, fermentation technology to convert biomass into bio-ethanol is discussed primarily.

6.7.3.6.2 Unit's Objectives:

6.7.3.6.2.1: Comprehension: Describe: To describe the advantages and disadvantages of ethanol as an automobile fuel considering it's physical and chemical properties
6.7.3.6.2.2: Application: Prepare: To prepare the ethanol production process block diagram covering pre and post treatment steps along with reactions and microorganisms involved (if any) in each step.

Module learning Strategy for Self Learning:

SN	Unit	References
1	Biomass: potential, sources and characteristics	• Tiwari, G.N. &Ghosal, M.K., "Renewable energy resources: Basic Principles and Applications", Narosa Publishing house, New Delhi. Page no: 172 to 180. • Rai, G.D., "Non-conventional Energy Sources" Khanna Publishers, New Delhi. Page no: 313 to 319. • Abbasi, T &Abbasi, S.A., "Renewable Energy Sources: Their impact on global warming and pollution", PHI Learning Private Limited, New Delhi, Page no:55 -62 • Basu, P., "Biomass Gasification and Pyrolysis: Practical Design and Theory", Academic Press, MA, USA Page no: 27 -63
2	Thermo-chemical Conversion of biomass: Introduction	• Basu, P., "Biomass Gasification and Pyrolysis: Practical Design and Theory", Academic Press, MA, USA Page no: 10 -19 • Tiwari, G.N. &Ghosal, M.K., "Renewable energy resources: Basic Principles and Applications", Narosa Publishing house, New Delhi. Page no: 188 to 203.
3	Gasification: Theory	• Basu, P., "Biomass Gasification and Pyrolysis: Practical Design and Theory", Academic Press, MA, USA Page no: 117-128

SN	Unit	References
		• Tiwari, G.N. &Ghosal, M.K., "Renewable energy resources: Basic Principles and Applications", Narosa Publishing house, New Delhi. Page no: 192 to 197.
4	Types of gasifier and performance evaluation	• Basu, P., "Biomass Gasification and Pyrolysis: Practical Design and Theory", Academic Press, MA, USA Page no: 130-136 & 192-204 • Tiwari, G.N. &Ghosal, M.K., "Renewable energy resources: Basic Principles and Applications", Narosa Publishing house, New Delhi. Page no: 198 to 201.
5	Biochemical conversion of biomass: Digestion	• Abbasi, T &Abbasi, S.A., "Renewable Energy Sources: Their impact on global warming and pollution", PHI Learning Private Limited, New Delhi, Page no:75 -124 • Tiwari, G.N. &Ghosal, M.K., "Renewable energy resources: Basic Principles and Applications", Narosa Publishing house, New Delhi. Page no: 203 to 221.
6	Biochemical conversion of biomass: Fermentation	• Tiwari, G.N. &Ghosal, M.K., "Renewable energy resources: Basic Principles and Applications", Narosa Publishing house, New Delhi. Page no: 221 to 225.

6.8 Module: Fuel Cells

6.8.1 Module Overview:

Energy conversion in fuel cells is relatively simple and direct in comparison to the heat engines. A fuel cell consists of a pair of an anode and cathode along with an electrolyte. At the anode side, the fuel gets oxidized electrochemically to producer positively charged ions with release of electrons. At the cathode side, oxygen molecules are reduced to oxide or hydroxide ions with the electrons consumption. The electrolyte serves to transport either the positively charged or negatively charged ions from anode to cathode or cathode to anode. The electrons are transferred through the circuit and generate the electricity. This module covers the principles and operations of various fuel cells such as alkaline fuel cell, proton exchange membrane fuel cell, phosphoric acid fuel cell, molten carbon fuel cell and solid oxide fuel cell. This module also discusses the thermodynamics and thermal efficiency of the fuel cell.

6.8.2 Module Objectives:

6.8.2.1 Analysis: Analyze: To analyze the comparative performance of the fuel cells such as alkaline fuel cell, proton exchange membrane fuel cell, phosphoric acid fuel cell, molten carbon fuel cell and solid oxide fuel cell.
6.8.2.2 Evaluation: Evaluate: To evaluate the performance of the fuel cell in terms of voltage efficiency and thermal efficiency and applicability potential.

6.8.3 Module Units:

6.8.3.1 Unit: Fuel Cell: Introduction

6.8.3.1.1 Unit's Summary :

A fuel cell is an electrochemical device which harnesses the chemical energy of fuel to produce electricity without involving a combustion cycle. Hydrogen is used as a fuel to produce electrons, protons, heat and water. The electrons can be harnessed to provide electricity in a consumable form through a simple circuit with a load. Hydrogen fuel is supplied to the anode (negative terminal) of the fuel cell while oxygen is supplied to the cathode (positive terminal) of the fuel cell. Through a chemical reaction, the hydrogen is split into an electron and a proton. Each takes a different path to the cathode. The electrons are capable of taking a path other than through the electrolyte, which, when harnessed correctly can produce electricity for a given load. The proton passes through the electrolyte and both are reunited at the cathode. The electron, proton, and oxygen combine to form the harmless byproduct of water.

6.8.3.1.2 Unit's Objectives:

6.8.3.1.2.1: Application: Prepare: To prepare the schematic representation of a fuel cell by clearly describing the reactions involved at anode and cathode, ions transferred, fuel used, oxidant used, and electrode wastes.

6.8.3.2 Unit: Fuel Cell: Classification

6.8.3.2.1 Unit's Summary :

The applications of fuel cells vary depending on the type of fuel cell to be used. Since fuel cells are capable of producing power anywhere in the 1 Watt to 10 Megawatt range, they can be applied to almost any application that requires power. There are mainly five types of fuel cell, classified based on the electrolyte used in them. Each of them having different characteristics and operating conditions.

6.8.3.2.2 Unit's Objectives:

6.8.3.2.2.1: Analysis: Analyze: To analyze the ion exchange mechanism involved in different fuel cells such as alkaline fuel cell, proton exchange membrane fuel cell, phosphoric acid fuel cell, molten carbon fuel cell and solid oxide fuel cell
6.8.3.2.2.2: Analysis: Compare: To be able to compare the performance of different types of fuel cell such as alkaline fuel cell, proton exchange membrane fuel cell, phosphoric acid fuel cell, molten carbon fuel cell and solid oxide fuel cell

6.8.3.3 Unit: Fuel Cell: Performance Evaluation

6.8.3.3.1 Unit's Summary :

The purpose of the fuel cell is to generate electricity which happens when oxygen and fuel combines in it. A fuel cell uses a chemical reaction to provide an external voltage like a battery. But the thing that makes fuel cell different from a battery is that in a fuel cell there is a continuous supply of fuel and oxygen. It produces

the electrical energy at a higher efficiency than just burning the hydrogen to produce heat to drive a generator. The only by-product is water; hence it is pollution free. This unit discusses the energy conversion efficiency of a fuel cell. It also discusses the voltage efficiency accounting the drop in voltage due to concentration polarization.

6.8.3.3.2 Unit's Objectives:

6.8.3.3.2.1: Analysis: Calculate: To calculate the electrical energy production per unit of fuel consumption
6.8.3.3.2.2: Evaluation: Evaluate: To evaluate the performance of a fuel cell in terms of energy conversion efficiency
6.8.3.3.2.3: Evaluation: Evaluate: To evaluate the performance of a fuel cell in terms of voltage efficiency accounting the drop in voltage due to concentration polarization.

Module learning Strategy for Self Learning:

SN	Unit	References
1	Fuel cell: Introduction	• Kothari, D. P., Singal, K.C. and Ranjan, R., "Renewable Energy Sources and Emerging Technologies", PHI Learning Private Limited, 2nd edition, pg no: 322 – 326.
2	Fuel Cell: Classification	• Kothari, D. P., Singal, K.C. and Ranjan, R., "Renewable Energy Sources and Emerging Technologies", PHI Learning Private Limited, 2nd edition, pg no: 326 – 332.
3	Fuel Cell: Performance evaluation	• Kothari, D. P., Singal, K.C. and Ranjan, R., "Renewable Energy Sources and Emerging Technologies", PHI Learning Private Limited, 2nd edition, pg no: 333 – 344.

6.9 Module: Energy Storage

6.9.1 Module Overview:

In addition to the inevitable depletion of the fossil fuels that are now the major sources of energy. Moreover, there are relatively smaller current alternatives are available. There is another matter that is very important is that the effective utilization of the energy that is available. These different types of applications have different requirements for access to energy, and different characteristics of its use. One of the major problems with the effective use of available renewable or nonrenewable energy supplies is that the schedule of energy use is often not in synchronization with acquisition. Thus, buffer, or storage systems are necessary. This module discusses the two kinds of energy storage systems such as mechanical energy storage and thermal energy storage.

6.9.2 Module Objectives:

6.9.2.1 Analysis: Analyze: To analyze mechanical and thermal energy storage systems in terms of capacity of the system, thermal resistance and material selection, discharge pattern, unit operations involved and utilities required.

6.9.3 Module Units:

6.9.3.1 Unit: Energy Storage: Mechanical Systems

6.9.3.1.1 Unit's Summary :

The intermittent energy can be stored as electrical energy and mechanical energy. Electrical energy options are batteries, capacitors and electromagnetic systems. Where as mechanical energy storage systems include compressed air, fly wheel and hydrostatic energy. This unit mainly discusses the various options of mechanical energy systems and briefly discusses the electrical energy options.

6.9.3.1.2 Unit's Objectives:

6.9.3.1.2.1: Synthesis: Prepare: To prepare the block diagram of the compressed air energy system by clearly describing the various unit operations and utilities required.
6.9.3.1.2.2: Synthesis: Prepare: To prepare the complete cycle (energy storage and energy utilization)for flywheel energy storage systems

6.9.3.2 Unit: Energy Storage: Thermal Systems

6.9.3.2.1 Unit's Summary :

The intermittent, varying and unpredictable nature of solar radiation generally leads to a mismatch between the rate and time of collection of solar enery and the load needs of a thermal application. This unit deals with the analysis of various thermal and chemical energy storage systems. It includes the basic methods of storing thermal energy by three different mechanisms namely sensible heat storage and latent heat storage systems storage systems.

6.9.3.2.2 Unit's Objectives:

6.9.3.2.2.1: Analysis: Analyze: To analyze the well mixed sensible heat liquid storage tank in terms of variation in temperature, make up liquid requirement, and size of the storage systems.
6.9.3.2.2.2: Evaluation: Compare: To compare the latent heat storage systems with sensible heat systems in terms of size of the system, thermal resistance and material selection.

Module learning Strategy for Self Learning:

SN	Unit	References
1	Energy Storage: Mechanical systems	• Abbasi, T & Abbasi, S.A., "Renewable Energy Sources: Their impact on global warming and pollution", PHI Learning Private Limited, New Delhi, Page no:217 -222
2	Energy Storage: Themal systems	• Sukhatme, S.P., "Solar Energy: Principles of thermal collection and storage", Tata McGraw Hill Publishing Co. Ltd., New Delhi, Page no:258 – 290.

		• Abbasi, T & Abbasi, S.A., "Renewable Energy Sources: Their impact on global warming and pollution", PHI Learning Private Limited, New Delhi, Page no:217 -222

7. Course lecture plan:

Lecture	Learning objective	Coverage	Text book chapters
1-3	Importance and applicability of renewable energy sources.	Energy Resources and Their Utilization, Environmental Aspects of Electric Energy Generation.	1, 2
4-9	Technology and economics of solar thermal systems.	Solar Radiation and Its Measurement, Solar Thermal Energy Collectors, Solar Thermal Energy Conversion Systems.	3, 4, 5
10-11	Technology and economics of photovoltaic systems.	Solar Photovoltaic System	6
12-18	Technology and economics of wind power.	Types of turbines and their aerodynamics. Theories of wind turbines. WECS components and state of art Feasibility of large wind turbines. Wind Farms.	7, 8
19-21	Technology and economics of small hydro.	Types and theories of small, mini, and micro hydro turbines. Hydroelectric systems and advantages at small hydro levels. Conversion apparatus and feasibility.	9
22-25	Technology and economics of geothermal, wave and tidal energy systems.	Geothermal Energy, Wave and tidal turbines. Harnessing wave energy, applicability and feasibility, Electric Power Generation by Ocean Energy.	10, 11
26-31	Technology and economics of biogas and biopower.	Biofuel production and gasification. Biopower generation methods with technical details: steam, combined cycle, cogeneration.	12
32-34	Fuel Cells, Hydrogen and Hybrid systems	Fuel Cells, Hydrogen Energy System, Hybrid Systems.	13, 14, 15
35-37	Environmental Impact	Environmental impacts of renewable energy sources and remedial measures. Global Climate Change	16
38	Cost analysis techniques.	Cost calculations based on external costs, payback periods, cost/benefit analysis. Issues in multi-unit planning.	12, Ref. 1
39-40	Case studies		

(Reference 1 is to be additionally used for different technology discussions as and when appropriate. All chapters of this e-text are available as Adobe pdf files from the RETScreen website, and can be downloaded free of cost.)

8. Evaluation scheme:

Component	Weightage(%)	Duration	Date & Time	Remarks
Test 1	15	30 min	16/09*	
Test 2	15	30 min	18/10*	
Test 3	15	30 min	14/11*	
Project/ Activity based evaluation/ online Quiz/ case studies	25		Details will be announced later	Take home/ online
Comprehensive Examination	30	120 min	05/12 FN	Closed book

*During scheduled class hour

9.Chamber consultation hours: To be announced in class.

10. Course notices: To be displayed Nalanda as and when appropriate.

11. Make up Policy: Make up will be given to only to genuine cases. The request application should reach the Instructor – in – charge before commencement of scheduled test.

IC, BITS F462

SECOND SEMESTER 2019-20 (II Semester)
COURSE HANDOUT

Date: 06.01.2020

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No	**:**	**MBA G523/BITS F490**
Course Title	**:**	**PROJECT MANAGEMENT**
Instructor-in-Charge	**:**	**Dr. Rajesh Matai**

1. Course Description: Understanding why project management is different than traditional management. In simple terms this course explains the all four management function project planning, organizing the project, project evaluation, and cost control and trade-off analysis in a project environment. This course is designed to cover all the knowledge and skills, required for a successful project manager. This covers both hard and soft aspects of projects.

2. Scope and Objective of the Course: The use of projects and project management is becoming more and more important for all kinds of organizations. Businesses regularly use project management to accomplish unique outcomes under the constraints of resources, and project management turn to be one of essential ways of achieving an organization's strategy. This course addresses the basic nature of managing general projects, not especially focuses on one type of project, no matter construction projects or R&D projects. The course uses the project life cycle as the organizational guideline, and contents will cover the whole process of project management, including project initiation, project planning, project implementation, and project termination.

3. Text Books:

T1 Clifford F Gray, Erik W Larson, Gautam V Desai, "Project Management: The Managerial Process" Mc Graw Hill Education (India) Private Limited, New Delhi, Sixth Edition, 2014.

4. Reference Books:

R1 Prasanna Chandra, "Projects: Planning, Analysis, Financing, Implementation and review" Tata McGraw Hill Fifth Edition 2002.

R2 Pinto K. J. Project Management Pearson Education Second Edition 2009

R3 Goldratt, E.M., Critical Chain (A Business Novel)

5. Course Plan:

Module No.	Lecture Session	Reference	Learning outcomes
I	1-2	T1.Chapter 1	To get a feel of project management environment ➢ What is a project? ➢ Importance of project management ➢ Project Life cycle, Project Manager
	3	Case Discussion	
	4-5	T1. Chapter 3	Understanding organization structures for projects ➢ Project management structures ➢ comparing different structures and selecting right one
	6	Case Discussion	
II	7-10	T1. Chapter 2 R1 Chapter 8	Understanding project selection techniques ➢ Project cash flow estimation ➢ Quantitative techniques i.e. Payback, NPV, IRR ➢ Qualitative techniques: AHP
	11	Case Discussion	
	12-13	T1. chapter 4	Defining the project ➢ What is project scope ➢ Understanding work break down structures ➢ Responsibility matrix ➢ preparing communication plan
	14-15	T1. chapter 5	Estimating project times and costs ➢ Identifying factors responsible for time estimates ➢ Different methods for time and cost estimation
III	16-18	T1 .chapter 6	Developing a project plan ➢ Developing project networks from work packages ➢ AOA and AON Networks, Network computation process ➢ PERT and CPM methods, practical consideration
	19	Class exercises	
	20-21	T1. chapter 8	Scheduling resources and costs ➢ Resource scheduling problems ➢ classification of scheduling problems ➢ multi-project resource schedules
	22	Class exercises	

	23-24	T1. chapter 9	Reducing project duration ➢ How to accelerate project ➢ cost duration graph
	25	Class Exercises	
IV	26-29	R3 Class notes	Critical chain scheduling ➢ Theory of constraint ➢ Critical chain concepts ➢ practical consideration
	30-32	T1. chapter 7	Managing risks ➢ Understand risk management process ➢ contingency planning ➢ change control management
	33-34	T1. chapter 11	Managing project teams ➢ Building high-performance teams with case discussion
	35-38	T1. chapter 13	Project performance management and evaluation ➢ The project control process ➢ Earned value concept and management developing a status report
	39-40	T1. chapter 14	Project Audit and closure

6. Evaluation Scheme:

Component	**Duration**	**Weightage (%)**	**Date & Time**	**Nature of component (Close Book/ Open Book)**
Mid-Semester Test	90 Min.	20	<TEST_1>	Close Book
Comprehensive Examination	3 h	40	<TEST_C>	Close Book
Research Papers presentations		10%	To be announced in class	Open Book
Participation in case discussions		10%		Open book
Mini Project		20%	At the semester end	Open book

7. Chamber Consultation Hour: To be announced in class.

8. Notices: All notices of this course will be displayed on the Department of Management Notice Board.

9. Make-up Policy: Make-ups may be allowed only in genuine cases with prior permission of I/C. No make-up will be granted for Case discussions/Mini Project presentations/Research Paper presentations.

10. Team Formation

Students have to give research papers and mini-project presentations in a team. Teams will be formed in class.

Instructor-in-charge
Course No. MBA G523/BITS F490

FIRST SEMESTER 2020-2021

Course Handout (Part II)

Date: 18/08/2020

In addition, to part I (General Handout for all courses appended to the timetable), this portion gives specific details regarding the course.

Course No.	**:**	**ECON F471**
Course Title	**:**	**Resources and Environmental Economics**
Instructor-in-charge	**:**	**DR. GEETILAXMI MOHAPATRA**
Other Instructor	**:**	

1. Course Description

This course will cover the theory and practice of environmental and natural resource economics; how economic analysis is applied to environmental and natural resource issues; and related policies that derive from those analyses. As one might expect, there is an absence of complete agreement among policy professionals on the best approach to environmental and resource management. Therefore the course will present the contrasting perspectives on the environmental and natural resource issues and policy. Particular emphasis will be on environmental and natural resource issues and policy in the context of the developing country like India.

2. Scope and objective of the course:

- To deal with foundations of resource and the environmental economics
- To have the main issues of modern resource and environmental economics identified
- To learn how economic activity depends upon and affects the natural environment the proximate drivers of the economy's impact on the environment – consider the argument that the environment sets limits to economic growth, the idea of sustainable development
- To focus be introduced to optimal growth analysis where production uses a non-renewable natural resource
- To learn about market failure and the basis for government intervention to correct it, how to determine how much of it the government should supply, learn about pollution (various forms) as an external effect, and the means for dealing with pollution problems of different kinds

3. **Text Book:**
   - Charles D. Kolstad, *Intermediate Environmental Economics*, Oxford University Press, 2nd Edition 2016 (Indian Edition)

4. Reference Books:
   - **R1**. Roger Perman, Yue Ma, James McGilvray and Michael Common, Natural Resource and Environmental Economics, Pearson Addison Wesley., 3rd Edition, 2003.
   - **R2.** Tietenberg Tom, *Environmental Economics and Policy*, Pearson Addison Wesley., 5th Edition, 2007.
   - **R3**. Janet M Thomas and Scott J Callan. *Environmental Economics*, Cengage Learning, Indian Ed. 2007.
   - **R.4:** Rabindra, N.Bhattacharya, "Environmental Economics (Ed)", 2001, Oxford University Press, New Delhi.

5. Course Plan:

Module No:	Lecture Session	Reference(TB)	Learning Outcome
Introduction	**L1.1:** What is Environmental Economics? **L2.1:** Positive versus Normative Analysis	Ch.1 and 2	Environment in the economics sense, simple model on the "Economy and the Environment", Which analysis is important and why?
Making Social Choice	**L3.1:** Individual Preference relating to environmental protection **L3.2:** Social choice from Individual Values	Ch.3	Understanding of the social choice from the perspectives of individual preferences based on utility function
Welfare and Market Failure	**L4.1:** Market Efficiency **L4.2:** Concepts related to market efficiency like production and exchange, **L5.1:** Market failure: open access, externalities, public goods **L5.2:**Pricing public goods and bads, concept of Green Accounting and importance of it	Ch.4 and Ch. 5	Understanding of the basics of market efficiency in terms of consumer and producer, and highlighting the cases where the market fails to operate efficiently
Decision Making and Environmental Protection	**L6.1:** Social Cost-Benefit Analysis **L6.2:** Cost Effectiveness Analysis	Ch.6	Understanding of the basis for making decisions related to environmental programs
Environmental Demand Theory.	**L7.1:** Types of Environmental goods **L7.2:** Difference between WTP and WTA, concept of discrete choice	Ch. 7	To identify the different types of environmental goods, difference between WTP for different types of goods
Environmental Valuation Methods: Revealed Preference	**L8.1:** Hedonic Price method **L9.1:** Travel Cost Method, **L.9.2:** Defensive Expenditure method	Ch.8 and 9	To identify and estimate some indirect method for determining the demand for environmental quality from Observed Behavior
Environmental Valuation Methods: Stated Preference	**L10.1:** Contingent Valuation Method **L10.2:** NOAA and experimental markets	Ch.10 and Notes	To identify and estimate some direct method for determining the demand for environmental quality
Environmental Valuation Methods: Market Valuation	**L.R3.6.1:** Market Method: Dose-Response Method	Ch.4 (R3) and class notes	To identify and estimate some objective preference based valuation
Determining the Optimal Level of Pollution	**L. R2. 14.1:** Economics of Pollution Control: An Overview. **L. R3. 4.1:** Conventional	Ch. 14 (R2) and Ch. 5 and Ch. 11 (R3) and Ch.12	To have an idea about the economics of pollution control, a case of command and control

	Solutions to Environmental Problems. **L. R3. 10.1:** Defining Air Quality: The Standard-Setting Process.	(TB)	policies,
Choosing Policy Instruments to Control Pollution	**L. R3. 5.1:** Economic Solutions to Environmental Problems **L.12.1:** Emission charges; a case of Pigovian tax **L13.1**.Markets and Property rights; a case of Coase theorem	Ch. 6 (R3) and Ch 12 and Ch. 13 (TB)	To identify the market–based and decentralized environmental policies for environmental Protection.
Renewable and Non-Renewable Resources	L.R1: 14.1: Simple optimal resource depletion model, fossil fuels L.R1: 14.2: Extraction cost and non-renewable resources L.R1: 17.1: Steady state harvest of renewable resources, a case of fishery and forestry. L.R1: 17.2:Dynamics of renewable resource harvesting L.R1: 18.1: Characteristics of forest resources, economics of forestry, ecosystem management	Ch 14, 17 and 18 (R1)	To determine optimal use and extraction of depleting natural resources, e.g fossil fuel and renewable resources with emphasis on fishery and forestry
Environmental Sustainability	LR1: 4.1: Introduction to the concept of environmental sustainability, development and growth, Innovation and sustainability	Ch. 20 (TB) and Ch.4 (R1) and notes	To understand the importance of environmental sustainability and linkage with SDGs
Environmental problem across the globe and in India	L31- 37: Typical problems: Air pollution, transportation, water pollution and scarcity, solid waste and recycling, toxic substances, pesticides and hazardous wastes, land degradation, deforestation, interlinkage between development, poverty and environment	Class Notes and notes from reference texts ch. 11- ch 20 (R3)	To get an idea of major environmental problem existing around the globe
International Institutions and Environmental policy across the globe and in India	L38-40 : IPCC, UNFCCC, Environmental policy prevailing in India related to air pollution, water pollution, environment protection etc. and the role of institutions in this regard in India	Class Notes and notes from reference texts (R4)	To identify the role of various institution for tackling the various environmental issues and the role of policies prevailing in India related to it

6. Evaluation Scheme

Component	Weightage (%)	Date and Time	Duration	Nature of component
Test -I	15	10/9 To 20/9 (TBA	30 Min	
Test -II	15	9/10 to 20/10 (TBA)	30 Min	
Test -III	15	10/11 to 20/11 (TBA)	30 Min	
Comprehensive Examination	30	5 / 12 (FN)	2 Hrs	CB
Assignment and Viva	25		--	OB

7. Chamber Consultation Hours: **Friday (4.00-4.50 PM)**
8. Notice concerning this course will be displayed on the Nalanda. (LMS)

Instructor-in-charge
ECON F471

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

FIRST SEMESTER 2020-21
COURSE HANDOUT

Date: 13.08.2020

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **GSF212**
Course Title : **Environment, Development and Climate Change**
Instructor-in-Charge : **Dr. Sailaja Nandigama**
Instructor(s) : **N/A**
Tutorial/Practical Instructors: N/A

1. Course Description: This course focuses on the concepts of environment, development, and climate change in the contemporary world. The nature and causes of environmental problems in developing and developed countries will be explored. Attention is given to both the causes and solutions of environmental problems and the role of state and non-state actors interacting at local, national and global scales. The goal of this course is for the learners to appreciate the people-environment relations and to understand the anthropocentric dynamics of development and climate change.

2. Scope and Objective of the Course: The objective of the course is to make the students aware of the debates and issues relating to sustainable development and climate change. The course covers theory and practice at the global and local levels and examines the contemporary policy and practice regarding environment, development and climate change.

3. Text Books: Hempel, C. Lamont (1998), Environmental Governance: The Global Challenge, Affiliated East-West Press Pvt Ltd, New Delhi. (Reading material will be given by the IC)

4. Reference Books: Humphrey R. Craig, Tammy L. Lewis and Frederick H. Buttel (2002), Environment, Energy, and Society. Wadsworth Group, USA.
Note: Book chapters, journal papers, films and newspaper reports will be given in advance as preparation materials before sessions.

5. Course Plan:

Module No.	Lecture Session	Reference	Learning outcomes
1	TB: Chapter 1 Between Two Centuries (5)	TB (pp. 1-28) &Ref.	Students will be exposed to the concepts and their background through various historical examples
2	TB: Chapter 2 Earth Summit or Abyss (8)	TB (pp. 29-48) &Ref.	Students will be able to appreciate role of various demographic, sociological and political factors influencing the environment and development
3	TB: Chapter 3 Causes of Environmental Destruction (10)	TB (pp. 51-86) &Ref.	Students will learn to identify and critically assess institutional and

			socio-political causes for environmental destruction, and strategies for managing environment and natural resources through various theoretical concepts and case studies
4	TB: Chapter 4 Global Warming: The Changing Climate in Science and Politics (8)	TB (pp. 90-116) &Ref.	students will be able to differentiate between optimal and dangerous levels of Climate Change and its relationship with Development
5	TB: Chapter 5 The Environmental Policy-Making Process (10)	TB (pp. 119-147) &Ref.	Students will be able to analyze the everyday impact of human activities on environment and suggest models of mitigating it through action research and public policy

6. Evaluation Scheme:

Evaluation Component	Weightage (%)	Duration (Minutes)	Date of Evaluation
Test 1	15 (OB/CB)	30	September 10 –September 20 (During scheduled class hour)
Test 2	15 (OB/CB)	30	October 09 –October 20 (During scheduled class hour)
Test 3	15 (OB/CB)	30	November 10 – November 20 (During scheduled class hour)
Other Evaluation Components (including lab component, quizzes, assignments etc.)	20 (OB)	As desired by the Instructor(s)	Evenly spaced throughout the semester (To be completed by November 20)
Comprehensive Examination	35 (OB/CB)	120	As announced in the Timetable

7. Chamber Consultation Hour: Friday 10-11 am.

8. Notices: Shared on Nalanda and on the HSS notice board.

9. Make-up Policy: Only genuine cases will get make-up.

10. Note (if any): Course format will be interactive with regular class discussions and several group exercises, documentary screening and presentations. Students are expected to prepare in advance with the help of reading material provided and through self-initiative.

Dr. Sailaja Nandigama
Instructor-in-charge
Course No. GSF 212

SECOND SEMESTER 2017-2018

Course Handout Part II

Date: 06/01/2018

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : **GS F243**
Course Title : **Current Affairs**
Instructor-n-charge : **S. K. CHOUDHARY**

1. Scope and Objective of the course:

The objectives of the course are to instill in students the habit of keeping themselves updated on a host of issues that relate not only to an individual but the society at large and also to inculcate among the students the skills of reading, understanding, interpreting and forming an opinion on national and international events and issues of different nature and of various domains.

2. Learning Outcomes:

Having successfully completed all the modules of the course, students will be able to

- ✓ Read about, listen to, interpret and understand current issues covered in print, visual and electronic media
- ✓ Analyze an issue from various perspectives and understand their implications for an individual, a nation and the society at large
- ✓ Identify ideological biases in people's opinion
- ✓ Form their informed opinion on any given issue
- ✓ Express their opinion in an effective manner

2. Text Book:

Hartley, J. *Understanding News*. London: Routledge. 1991 (2nd Edn.).

3. Reference Materials:

(i) Fink, Conrad C. *Writing Opinion for Impact*. Delhi: Surjeet Publications. 2005.

(ii) Wallace, Michael J. *Study Skills in English.* New Delhi: CUP Foundation Books Pvt. Ltd. 2007.

(iii) National Newspapers and News magazines like India Today and Outlook

4.Course Structure:

Lecture No.	Learning Objectives	Topics to be covered	Reference Unit	Learning Outcome
1-2	Current Affairs-An overview	Introduction to, Importance and scope of Current Affairs	Ch. 1	To understand importance of issues in current affairs
3-4	To understand various domains of current affairs	Domains of Current Affairs-Political, Social, Religious, Scientific, Developmental, etc.	Ch. 3	To know how to categorize issues into various domains
5-6	To understand the importance of reader as well as writer's background in interpreting any events/issues/news	Issues in Current Affairs-Controversial, Non-controversial, Neutral	Ch. 4	To realize how certain issues generates enormous reactions from various sections of society
7-9	To explore the possible sources of current affairs	Sources of Information in Current Affairs-newspapers, Magazines, Posters, Pamphlets, Manifestoes, Recently published books, etc.		To know the sources of information related to current issues
10-14	To develop the skills of reading and understanding	Reading: Skimming & Scanning; Extensive vs. Intensive; comprehension	Supplementary materials	To learn various skills of reading
15-16	Reading and conceptualizing meaning of events/issues/news	Understanding current issues, events and information	Ch. 2	To learn how to understand the content of an issue
17-18	Exploring implications	Interpreting current issues, events and information	Ch. 8	To learn how to analyze an issue
19-22	Opinion formation and role of ideology	Opinion formation-factors and materials influencing opinion formation	Ch. 9	To learn how to form one's opinion on a given issue

23-24	Neutralizing ideological bias	Balancing opinion	Ch. 10	To learn how to identify the ideological biases in someone's opinion
25-26	Presentation of views/opinion	Expressing opinion	Ch. 9 & 10	To develop the skill of giving one's opinion
27-30	Interacting/ listening / forming ideas/opinion	Guest Expert lectures and interactions		To develop the skills of listening and interpretation
31-40	Reading, discussion, formation and presentation of opinions	Practical		

5. Evaluation Scheme:

EC.NO.	Evaluation Component	Weightage	Duration	Date, Time	Remarks
1	Mid Semester Test	60	90 mts	8/3 2:00 -3:30 PM	Open Source (based on previous week's Newspapers)
2	Quiz	20			CB
3	Assignments*	40			
4	Comp Exam	80	3 Hrs	9/5 FN	Close Book

6. *Class Assignments:
Assignment: Written-40 (Home take -20; class-20)

7. Chamber Consultation Hour: To be announced in the class.

8. Notices: The notices concerning the course will be displayed on the HSS Dept. notice board.

9. Make-up Policy:

The make-up for an evaluation component will be given only in genuine cases. However, the student has to contact his/her instructor for his/her approval. In these matters his/her decision shall be final.

Instructor-in-charge

BITS C393

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
Pilani Campus
AUGS/ AGSR Division

FIRST SEMESTER 2019-2020
COURSE HANDOUT (Part II)

Date: 22.07.2019

In addition to Part I (General Handout for all courses appended to the time table) portion:

Course Number : **MATH F432**
Course Title : **Applied Statistical Methods**
Instructor-In charge : **Dr. Sumanta Pasari**
Instructor : **Dr. Sumanta Pasari**

1. Course Description:

Applied Statistics is an exciting sub-area of Statistics. It has application in almost all science disciplines which deal with data and uncertainty. This course builds up fundamental concepts of various key statistical methods necessary to analyze/interpret a variety of practical business/engineering problems. This course emphasizes the role of statistics in one's own field of study by making sense of data, developing self-ability to apply appropriate statistical methods, performing experimental designs and above all, realizing the limitations/inherent assumptions in a statistical test to avoid over interpretation or misinterpretation. The thrust areas covered in this course include probability distributions, statistical inference, analysis of variance (ANOVA), regression and correlation, discriminant analysis, factor and cluster analysis, time series analysis and forecasting, nonparametric methods and statistical quality control. The theoretical learning will be complemented with various case studies and hands-on training in excel.

2. Scope and objective of the course:

This 4th level course is designed with a two-fold purpose. First, it will provide an exposure to various theoretical univariate/multivariate methods and their practical applications. Second, this course will improve methodological/analytical maturity to attempt a variety of problems using MS-excel toolbox.

3. Text Book:

T1: David R Anderson, Dennis J Sweeney, Thomas A Williams, Jeffrey D. Camm and James J. Cochran, Statistics for Business and Economics,12th Edition, Cengage Learning, 2014

4. Reference Books:

1. Deepak Chawla and Neena Sondhi, Research Methodology, Vikas, 2012
2. Richard Johnson and Dean W Wichern, Applied Multivariate Statistical Analysis, Pearson, 2007

5. Lecture Plan:

Lecture	Learning Objectives	Topics to be covered	Chapter in the Text Book
1-2	It helps students to recapitulate the introductory probability concepts.	Revision of basic probability concepts, random variables, probability distributions, moments	Chapter 4 to Chapter 6 (T1)
3-4	It enhances the understanding of different sampling procedures, sampling	Introduction, Review of sampling, Selecting a sample, Sampling from a finite and infinite population, Point Estimation, Sampling	7,7.2,7.3,7.4,7.5,7.7,7.8 (T1)

	distribution and inferential procedures.	distribution of sample mean and properties of point estimators, Other sampling methods	
5-6	It helps in understanding the concepts of hypotheses, and its errors followed by decision scenarios.	Interval estimation, Population mean when σ is known, Population mean σ is unknown, Determining the sample size, Introduction to hypothesis testing, Types of errors, Inferences about single population mean.	8,8.1,8.2,8.3 (T1) 9,9.1,9.2,9.3 (T1)
7-8	To gain knowledge on importance of variance, chi-square distributions and its types.	Inferences about difference of two means, Inferences about population variances, Interval estimation.	10,10.1,10.2,10.3,11,11.1.11.2 (T1)
9-11	It helps us to gain knowledge to obtain accurate and replicable findings at reasonable allocations of resources. We review some general principles of designs and its types.	Testing the equality of population proportions, Test of independence, Goodness of fit test, Introduction to experimental design and Analysis of Variance (ANOVA) (Completely randomized design, Multiple comparison procedures, Randomized block design)	12,12.1,12.2,12.3 (T1) 13,13.1,13.2,13.3,13.4 (T1)
12-14	To gain knowledge on basic regression model.	Simple linear regression model, Least squares method, Coefficient of determination, Model assumptions, Test for significance, Using the estimated regression equation for estimation and prediction, Residual analysis: Validating model assumptions, outliers and influential observations.	14,14.1,14.2,14.3,14.4,14.5,14.6,14.8.14.9 (T1)
15-17	It helps in	Multiple regression	15,15.1,15.2,15.3,15.4,15.5,15.6,15.8 (T1)

	understanding more than two variables in regression analysis and also gives insight on the concept of multicollinearity.	model, Least squares method, Multiple coefficient of determination, Model assumptions, Testing for significance, Multicollinearity. Regression equation for estimation and prediction, residual analysis, Discuss case studies.	
18-20	It gives exposure to distinguish between Categorial Independent and Categorical Dependent Regression Analysis.	Categorical independent variable, Logistic regression.	15.7,15.9 (T1)
21-23	It helps in assessing the classification accuracy of model.	Hoteling T^2 and Mahalanobis D^2 discriminant analysis, Objectives and its uses, Illustration of discriminant analysis, Assessing classification accuracy.	17 (R1)
24-27	It helps in understanding hierarchical, non-hierarchical cluster analysis.	Cluster analysis- a classification technique, Statistics associated with cluster analysis, An illustration of the technique, Key concepts in cluster analysis, Process of clustering, Establishing cluster algorithms, Discuss case studies	18 (R1)
28-31	It helps in understanding data reduction methods.	Factor analysis and its uses, Conditions for a factor analysis, Illustration of factor analysis, Applications of factor analysis in other multivariate technique.	7.1, 7.2, 7.3, 7.4 (R1)
32-35	It gives basic	Forecasting,	17.1 – 17.6 (T1), Class Notes

	idea on forecasting methods.	Components of a time series, Smoothing methods, Trend projections, Trend and seasonal components, Regression analysis, Qualitative approaches.	
36-37	It helps in understanding distribution free methods in parallel to parametric procedures.	Kruskal walls test, Mann Whitney Wilcoxon test, K-S two sample test	18.1-18.4 (T1), Class Notes
38-40	Statistical Quality Control	Introduction, Control charts for variables, Control charts attributes, Modified control charts.	19.1, 19.2 (T1), Class Notes

6. Evaluation Scheme:

EC. No	Evaluation Component	Duration	Weightage	Date & Time	Remarks
EC-1	Mid Semester	90 minutes	30		Closed Book
EC-2	Quizzes (Best 2 out of 3)	15 minutes each	10		Closed Book
	Assignment (one)	E-mail submission	15		Group work
EC-3	Comprehensive Exam.	180 minutes	45		Closed / Open Book

7. Chamber Consultation hours: To be announced in class.

8. Notices: All notices in relation to the above course will be put up on NALANDA.

9. Make up policy: Make up for mid-sem/comprehensive examination will be granted only in genuine cases. Permission must be taken in advance except in extreme cases. There will be no make up for the EC-2 at any circumstance.

Instructor in Charge
MATH F432

FIRST SEMESTER 2020-2021
Course Handout (Part II)

Date: 18/08/2020

In addition to Part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No **: ME F266**
Course Title **: Study Project**
Instructor-in-charge **: MANI SANKAR DASGUPTA**

1. **Scope and Objective of the course:**

The course is specially designed to provide an opportunity to the students for development of their academic skills and logical thinking through open ended study oriented activities. As a part of education, this project course follows a method of learning and therefore, the student's actual day-to-day task involvement would constitute the central thread of the learning process. The evaluation will recognize this aspect by demanding day-to-day productivity and punctuality of the student.

2. **Plan of Work:**

The plan of work for each student will be decided by the respective Instructors. Each student should adhere to the plan of work decided for and should regularly monitor the progress of the project accordingly.

3. **Evaluation Scheme:**

S.No.	Components	Weightage %	Due Date
1.	Project Outline & Plan of Work	10	16.08.2020
2.	Regular Interaction	10	10.09.2020
3.	Seminar I/Viva I	10	23.09.2020
3.	Midsem Report	15	05.10.2020
4.	Midsem Seminar	15	05.10.2020
5.	Final Report	20	27.11.2020
6.	Final Seminar and Viva	20	27.11.2020

4. **Mid-semester grading:**
Mid-semester grading will be done after mid-semester seminar.

5. **Grading Procedure:**
In addition to what is mentioned in Part I of the handout, the grading will be done mainly on the basis of the progress made towards attainment of the project objectives and will recognize that each Instructor has given specific task situation in which the student participates in a cognitive manner. **Thus each Instructor will recommend a grade for his student for the consideration of the Instructor-in-charge.** In a specialized course of this nature the respective Instructor's assessment of the student vis-a-vis the objective of the project would be the central criteria for arriving at final grade.

6. **General:**
It is the student's responsibility to ensure:

- Continuous interaction with the Instructor.
- Work to the satisfaction of the Instructor.
- Adherence to plan of work.
- Evaluation(s) to be completed by the due date and evaluation marks are communicated to the Instructor-in- charge by due date.

7. **Notices:**
All notices pertaining to this course will be put up on the Notice Boards of Mechanical Engineering Department.

8. **Project Report**
The project report shall be submitted to your Instructor.

Instructor-In-Charge
(ME F266)

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

FIRST SEMESTER 2021-2022

Course Handout Part II

Date: 17/08/2020

In addition to part -I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

LPU	**:**	**303**
Course No.	**:**	**ME F340**
Course Title	***:***	***Introduction to Sports Engineering***
Instructor-in-Charge	**:**	**M. S. Dasgupta**
Team of Instructors	**:**	**Pintu Modak, Rajesh P Mishra, Pratik Sheth, Dr. Achint Nigam**

1. **Course Description:** The course essentially prepares engineering students to utilize their existing technical knowhow for sports applications. Specific focus is on Mechanics, Materials, Design principles and data analysis. The course introduces students to sports biomechanics, analysis of human movement in sports, Force and motion analysis using various standard techniques, sensors, data analysis and performance measure. Sports equipment and surface property affecting performance and injury.

2. **Scope & Objective:** This is an introductory course to impart knowledge and skill set related to working with human in sports engineering application. Understanding human movement pattern and performance measurement. Understand, assess and analyze effect of equipment, sports surfaces and environment on sports performance. Use of ergonomic concepts, image processing, smart sensors and data analysis in sports engineering. Standard techniques of evaluation and testing of sports equipment and sports surfaces and appreciation of business around sports industry.

3. **Learning outcome:** On successful completion of this course, students will be able to:

    a) Explain what is sports engineering application domain.
    b) Demonstrate how to frame a sports engineering related problem and apply suitable engineering solution.
    c) Assess effect of sports surfaces and equipment on sports performance.
    d) Demonstrate use of information technology tools for performance analysis.

4. **Text Books:**
    (T1) Sport and exercise biomechanics - P. Grimshaw, New York: Taylor & Francis, 2007
    (T2) Introduction to Sports Biomechanics: Analysing Human Movement Patterns,2nd edition byRoger Bartlett, Routledge Publishing, 2007

5. **Reference Books:**
    (R1) Materials in sports equipment – Mike Jenkins, Woodhead Publishing 2003 UK
    (R2) Kinesiology: Scientific basic of human motions, By Katharina F Wel's and Kathryn Luttgens, 6th Edition, Philadelphia

(R3) The Science and Engineering of Sport Surfaces Edited by Sharon Dixon, Paul Fleming, Iain James, Matt Carré
(R4) Database systems: a practical approach to design, implementation and management (5th edition), Connolly, Thomas M. and Carolyn E. Begg, Addison-Wesley 6th Edition, 2015
(R5) The Routledge Handbook of Ergonomics in Sport and Exercise Youlian Hong, 2014 Routledge

6. **Course Plan:**

Sl. No.	Module	Lecture session duration hour	Chapter, Section (Book)	Learning outcome of module
1	**Sports and Technology** Introduction to Sports engineering and sustainability Objectives and scopes of sports engineering Connecting engineering with sports development.	**5**	**T1 Ch:1,2** **R4 Sec:1,2**	Learning fundamental skills that Engineering students require to understand sports movements. Technology and sports ethics.
2	**Human Movement Patterns** Defining human movements Some fundamental movements and Movement patterns, qualitative and quantitative methods	**8**	**T2 Sec:1,2,3,4**	Learning human movement patterns and their analysis
3	**Ergonomics and Anthropometry** Introduction to ergonomics, system design and task analysis Introduction to anthropometry and its application in sports. Anthropometry measures and anthropometric techniques	**8**	**R5 Sec:1,2,5** **T1 Sec:2,3**	Learning basic human factors in engineering design
4	**Performance Analysis of Sports Movements** What is Performance Analysis of Sport? Quantitative and Qualitative Analysis, Sports Performance Data and Information Computer application in sports Computerized Performance Analysis Systems and AI	**6**	**T1 Sec: 1,2,4,6**	Learning modern computing technology and its use in sports performance analysis
5	**Business around Sports** Introduction to sports as a product and a service. Pricing and promotion strategies in sports marketing.	**2**	**Reading material will be supplied**	Learning about marketing opportunities of sporting events and business around sports.
6	**Sports Infrastructure and Surfaces** Basics of sports Infrastructure. Planning design and management of sports infrastructure. History and development of sports Surfaces, surface Classification and characterization, surface test methods. Sports Surfaces	**6**	**R3 Sec:1,2,3** **R5 Sec:6**	Learning key aspect of sports infrastructure surface development, testing and effect on performance

	and Performance. Chemistry of Sports Surface.			
7	**Equipment Case Studies:** Materials and design of sports products – balls, tennis rackets, cricket bats, bicycles, running shoes, pole vaults, surfaces and training equipment case studies and measurements	**5**	**R1 Sec:8**	Visualize situations that engineers need to analyze and appreciate in Sports engineering problem and scope of business around sports

4. Evaluation Scheme:

Evaluation Component	Weightage (%)	Duration (Minutes)	Date of Evaluation
Test 1	10	30	September 10 –September 20 (During scheduled class hour)
Test 2	15	30	October 09 –October 20 (During scheduled class hour)
Test 3	15	30	November 10 – November 20 (During scheduled class hour)
Field assignment & Project	30	-	Evenly spaced throughout the semester (To be completed by November 20)
Comprehensive Examination	30	120	As announced in the Timetable

Chamber Consultation Hour: To be announced in the class.

Notices: Notification in Nalanda.

Make-up policy: No make-up possible for Quiz type tests, Make-up for Compre, only to take care of exigencies.

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

AUGS DIVISION

SECOND SEMESTER 2019-2020

Course Handout (Part II)

07/01/2020

In addition to part-I (general handout for all courses in the time-table), this handout provides the specific details regarding the course.

Course No.: **ME F420**

Course Title: **Power Plant Engineering**

Instructor-in-charge: **P.SRINIVASAN.**

Tutorial Instructors: **A R Hare krishnan**

Scope and Objective: This course has been design to make the students familiar with the Power Plant Engineering and Technology. It deals with the Thermal, Hydro, and Nuclear Power Plants. The course also discusses non-conventional power generation. The economic analysis, economic loading, load curve analysis will also be discussed.

Learning Objective:

LO1: Understanding the working principle of different types of power plants.

LO2: Economics of power generation and selection of different energy sources for power generation.

LO3: Thermal design of coal based power plants.

L04: Environmental impact of Power Generation

Text Book:

Nag P.K. *Power Plant Engineering*, Tata McGraw-Hill Pub. Co. Ltd, New Delhi (Fourth Edition), 2016, Eighth Reprint 2016.

Reference Books:

1. **Bernhardt G.A. Strotzki and William A. Vopat**, "*Power Station Engineering and Economy*" - Tata McGraw-Hill Pub. Co. Ltd. New Delhi , 1960
2. **M.M. El-Wakil**, "*Power plant Technology*" – McGraw-Hill International Edition, 1984.
3. **S P Sukhatme J N Nayak**, " Solar Energy Principle of Thermal Collection and storage", Tata McGrawhill 2008.
4. Basics of Boiler and HRSG Design, Brad Beukcer. 24x7 E book of BITS,Library. http://library.books24x7.com/toc.aspx?bookid=17316.

Course Plan:

Lect. No	Learning Objectives	Topics to be covered	Ref to text
1.	Introduction and power scenario of India and need for power plant engineering.	Introduction and Selection of Power Plant	Class notes
2.	Steam power cycles analysis for power generation	Analysis of steam cycles	Ch. 2
3.	Efficiency improvement of stem power cycles to generate electricity from economic perspective,.		
4.	Working of fluid power cycles increasing efficiency using combined cycle.	Combined cycle Power Generation	Ch. 3
5.	Important fuels	Fuels and combustion	Ch. 4

Lect. No	Learning Objectives	Topics to be covered	Ref to text
6.	Stoichiometry		
7.	Control of excess air		
8.	Draught systems & fans	Draught systems and fans	Ch. 4
9.	Enthalpy value of combustion		
10.	Kinematics	Combustion mechanism, Firing methods	Ch. 5
11.	Fluidized bed combustion		
12.	Coal gasification		
13.	Types of boilers	Steam Generators	Ch. 6
14.	Efficiency improvement of boilers		
15.	Efficiency improvement of boilers		
16.	Pollution control of boilers		
17.	Nozzles	Steam Turbines	Ch. 7
18.	Turbine blading		
19.	Electrical energy generation		
20.	Condensers	Feed water, Circulating water system	Ch. 8
21.	Cooling towers		
22.	Feed water treatment	Feed water treatment	Ch. 6
23.	Power Plant layout	Power Plant layout	----
24.	Optimization of hydro-thermal mix	Hydroelectric Power Plant	Ch. 10
25.	Hydro turbines		
26.	Cavitation		

Lect. No	Learning Objectives	Topics to be covered	Ref to text
27.	Performance of turbines		
28.	Types of plants	Diesel engine, Gas Turbine Power Plants	Ch. 11
29.	Efficiency evaluation		
30.	Basics	Nuclear Power Plant	Ch. 9
31.	Nuclear reactors		
32.	Nuclear reactors		
33.	Renewable energy sources	Non-Conventional Power Generation	Class Notes
34.	Solar and Wind based power generation		
35.	Biomass , Geothermal & other sources for power generation		
36.	Load curve	Economics of power generation	Ch. 1
37.	Availability of power		
38.	Power plant economics		
39.	Electricity pricing		

Evaluation Scheme:

Components	Duration	Weightage (%)	Date & Time	Remarks
Mid semester test	90 min.	25%	12/3 2:00 - 03:30 PM	Closed Book
Project presentation and report of case study.	__	15%		Open book.
Tutorial Tests*	50 min.	20%		6 best of 9 (OB)
Comprehensive Examination	3 hrs.	40%	4/5 FN	Closed Book

***filed visit may also be arranged for power plant.**

Mid-semester grading: It will be announced normally in the month of March. It is done in the same manner as that of the final grading

Chamber Consultation Hours: To be announced in the class.

Notices: All notices related to this course will be put on the Mechanical Engineering Group notice board only.

Make-up Policy: Make-up will be given only to the genuine students. The request application for make-up test must reach the Instructor-in-charge before commencement of the scheduled test (documentary proof is essential). No make-up will be allowed for the Tutorial tests.

Prof.P.Srinivasan

Instructor-in-charge

ME F420 Power Plant Engineering

SECOND SEMESTER 2019 – 2020

Date: 05.01.2020

Course Handout (Part II)

In addition to Part-I (general handout for all courses in the time-table), this handout provides specific details regarding the course.

Course No.:	ME F461
Course Title:	Refrigeration and Air-conditioning
Instructor-in-charge:	Dr. Suvanjan Bhattacharyya
Co-Instructors:	-----

1. Course Description: This course will teach the basic principles of refrigeration and air-conditioning to students, including the design and analysis of refrigeration and air-conditioning systems.

2. Scope and Objective of the Course: The course is designed to give an in depth study of theory of refrigeration and air-conditioning and their applications. The technique of analysis and design of refrigeration and air-conditioning systems will also be discussed.

3. Text Books:

1. **Text Books:** Arora, C.P. Refrigeration and Air-conditioning, 3rd Ed., McGraw-Hill India, 2009.

4. Reference Books:

1. Arora, R.C. Refrigeration and Air-conditioning, Prentice Hall India, 2010.
2. Stoecker,W. Jones J. Refrigeration and Air Conditioning 2nd Ed.
3. Faye C. McQuiston, Jerald D. Parker, Jeffrey D. Spitler, Heating, ventilating and air conditioning: analysis and design, 6th ed., Wiley, 2004.
4. P N Anathanarayanan, Basic Refrigeration and Air Conditioning, 4th Ed., 2013, McGraw-Hill Education.
5. Rajput, R. K. Refrigeration and Air-conditioning, 4th Ed., 2015, S. K. Kataria and Sons.

5. Course Plan:

Module No.	Lecture Session	Reference	Learning outcomes
1	**Introduction and review**	1, 2	Concepts of Refrigeration and Air-conditioning. Unit of refrigeration, Refrigerants.
2-4	**Simple Vapour Compression Refrigeration System(Simple VCRS)**	3	Vapour compression cycle on ph and T-s diagrams, Vapor compression systems calculation, Cycles with subcooling and superheating, their effects, actual Vapour Compression Cycle.
5-6	**Refrigerants**	4	Designation, comparative study of refrigerants and their selection, chemical and physical requirements, and substitute of refrigerants.
7 - 9	**Vapour Absorption Refrigeration System (VARS)**	12	Advantages of VARS over VCRS. Working principle of simple VARS, practical VARS. Limitations of VARS, maximum COP of a VARS, Lithium bromide-water System; Aqua-ammonia systems.
10-11	**Air Refrigeration System (ARS).**	11	Bell-Coleman refrigerator. COP determination, actual air refrigeration Cycle.
12 - 15	**Major Refrigeration Equipment.**	6, 7, 8, 9	Compressors: Types; reciprocating, rotary & centrifugal, Condensers: types used in refrigeration systems; Evaporators: types and heat transfer in evaporators. Expansion devices: types of expansion devices and capillary tubes and ejector expansion.

16 - 20	**Psychrometry of air conditioning Processes.**	14, 15 and Class Notes	Basic definitions and principles related to Psychometry ; Psychometric Charts & Their Uses; Heating, Cooling, Heating & Humidification & Cooling & Dehumidification processes. Adiabatic Saturation, Cooling Coils, By-pass Factor.
21 – 22	**Duct.**	21 and Class Notes	Duct Sizing & Design
23 - 24	**Design conditions.**	16	Inside and outside design conditions
25 – 27.	**Load calculations.**	19 and Class Notes	Sensible Heat Factors. Heat Load estimation: Simple cases of Cooling and Dehumidification.
28 – 29.	**Human Physiology**	Class Notes	Thermodynamics of human body.
30 – 31.	**Thermal Comfort**	Class Notes	Requirement of comfort air-conditioning.
32.	**Solar Cooling**	Class Notes	Solar cooling technologies
33 – 34.	**Air-conditioning equipment.**	Class Notes	Air-handling units, Cooling Towers.
35.	**Non-conventional cooling techniques**	Class Notes	ODP, GWP, TWEI

6. Evaluation Scheme:

Components	Duration	Weight age (%)	Date & Time	Remarks
Lecture Test	50 min.	10	Will be announced	Closed book
Group Presentation	15 min	10	Will be announced	Open Book
Mid Semester Test	90 min.	35	<TEST_1>	Closed book
Comprehensive Test	3 h	(15 + 30)	<TEST_C>	Close Book and Open Book

7. Chamber Consultation Hours (Instructor In-charge): Room No.: 2243-D, FD-II. Time: 5.00-6.00 PM, Wednesday.

8. Notices: All notices related to this course will be put on the Nalanda.

9. Make-up Policy:
1. Make up will be given to genuine students only, but prior permission is required.
2. No makeup for group presentation and lecture test.

10. Note:

I). NC will be given to students obtaining overall marks less than 20% of the total (less than 20 out of 100).

II). Mid-semester grading: It will be announced normally in the month of March. It is done in the same manner as that of the final grading.

III). Group Presentation: One before mid-semester test and one will be after mid semester test.

IV). Lecture Tests: Best two will be taken out of four. Two before mid-semester and two after mid semester.

Instructor-in-charge
Dr. Suvanjan Bhattacharyya
ME F461

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus

AUGS-AGSR Division
SECOND SEMESTER 2019-2020

Course Handout (Part II)

Date: 07/01/2020

In addition to part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course Number : **MF F421**
Course Title : **SUPPLY CHAIN MANAGEMENT**
Instructor In-charge : **SRIKANTA ROUTROY**

1. Scope & Objectives of the Course:

The course provides students with the opportunity to get clarity and insight into the phenomenon of supply chains and their management. It will assist in understanding Supply Chain Management (SCM) not as a technology issue but rather a business strategy for companies trying to create new competitive advantage. The objectives of the course are mentioned below:

i. Attain familiarity with the fundamentals of SCM and its use in organizations seeking to create differentiation.
ii. Provide a platform for supply chain analytics
iii. Understand issues in implementing SCM and e-fulfilment in a web enabled world.

2. Text Books:

T1: Sunil Chopra, Peter Meindl and D V Kalra, "Supply Chain Management: Strategy, planning and Operation", Pearson Education, Sixth Edition, India, 2016.

3. References:

R1: Donald J. Bowersox, David J. Closs, and M. Bixby Cooper "Supply Chain Logistics Management", Second Edition, Tata McGraw-Hill.

4. Course Plan:

Lect. No.	Topic to be Covered	Learning Objectives	Ref. To Text	Learning Outcomes
2	What is Supply Chain Management & how does it create Value?	Describe the cycle and push/ pull view of a supply chain Identify the key supply chain decision phases. Goal of supply chain & impact of supply chain decision on the success of a firm	Chapter 1 T1	Students will able to analyze strategically different processes of the supply chain in order to achieve competitive advantage.
3	Strategic Fit & Scope	Achieving strategic fit is critical to a company's overall success.	Chapter 2 T1	

2	Supply Chain Drivers and Metrics	Identify the major drivers of supply chain performance. Discuss the role each driver plays. Describe the major obstacles that must be overcome to manage a supply chain successfully.	Chapter 3 T1	
8	Designing the distribution network	Designing the distribution network in a supply chain, Network design in the supply chain, Network design in uncertain environment	Chapters 4, 5 & 6 T1	Students will able to analyze and design the supply chain configuration in a specific environment.
8	Planning demand and supply in supply chain	Demand forecasting in supply chain, Aggregate planning in the supply chain, Planning supply and demand in the supply chain: Managing predictable variability; Coordination in Supply Chain	Chapters 7, 8, 9 & 10 T1	Students will able to know the application of forecasting in different supply chain planning problems such as aggregate planning.
8	Planning and managing inventories in a supply chain	Managing economies of scale in the supply chain: Cycle inventory, Managing uncertainty in the supply chain: Safety inventory, Determining optimal level of product availability	Chapters 11, 12 & 13 T1	Students will able to analyze and model inventory in supply chain environment using different analytical tools.
6	Transportation, and Sourcing	Sourcing decisions in a supply chain, Transportation in the supply chain, Pricing and revenue management in the supply chain	Chapters 14 and 15 T1	Students will able to design both inbound and outbound logistics using system's perspective.
2	Sustainability and the supply chain	Introduction to sustainability; Issues and performance measures	Chapter 17 T1	Student will able to understand the various issues related to closed loop supply chain including environmental sustainability.

5. Evaluation Component

S. No.	Evaluation Component	Duration	Max. Marks	Date & Time	Remarks
1	Mid-Semester Examination	90 Min.	50 (25%)		Close Book
2	Surprise Quizzes		30 (15%)		
3	Project		40 (20%)	**To be announced in class**	
4	Comprehensive Examination	3 hrs	80 (40%)		Close Book

6. Chamber Consultation: 4-5 P.M. Tuesday.

7. Notices: All notices concerning this course will be displayed on the Mechanical Engineering Department Notice Board only.

8. Make-Up Policy: No students will be allowed to take make up without prior permission. For the case study and assignment / article/class presentation, no make ups will be granted.

Instructor - in - Charge
MF F421

PRACTICE SCHOOL PROGRAM

LINKS

THEORY LEARNT IN CLASS ROOM

PRACTICE IN THE INDUSTRY

WITH

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Theme of Practice School (PS)

Practice School is an educational innovation seeking to link industry experience with university instruction. The objectives of PS are to (i) meet the rapidly changing needs and challenges of a professional workplace, (ii) enable students to acquire learning by applying the knowledge and skills they possess, in unfamiliar, open-ended real life situations, and (iii) bear an economic relevance to society. These objectives are achieved by bringing the reality of the world of work into the process of education. PS creates the required setting for experiential and cooperative learning and education, by providing students with an opportunity to work on relevant assignments, under the guidance of professional experts and under the supervision of faculty. Consequently, Practice School serves as a platform that facilitates and promotes partnership and intellectual exchange between academia and industry.

Beginning of PS

Birla Institute of Technology & Science, Pilani introduced the PS programme in 1973 for all disciplines across the Institute. Though PS programme began in 1973 with merely 12 students and 4 faculty members at HINDALCO, Renukoot, it has been growing at a steady rate since then.

Salient Features

- Institutionalized linkage between University and Industry
- Applicable to all degree programs
- Integral part of the curriculum
- Student involvement in real-life projects
- Continuous Internal Evaluation system
- Monitoring and evaluation by resident faculty member

Programme Structure

Single Degree

- It is notionally of four years duration, with the input being 10+2 pass students who have qualified for admission through BITSAT (the online admission test of BITS Pilani).
- The first year is devoted to establishing a strong foundation in Maths, Sciences and Basic Engineering (Electrical, Electronics Engg, Computer Programming, Workshop), Technical Arts such as Report Writing.
- The Disciplinary Core courses starts in the second year itself. Along with Discplinary Core courses, Maths Foundation and General Awarness courses (Principles of Management/ Economics) and some Humanities electives are done by a student.
- Practice School-I is conducted during the summer following the second year.
- The third year is spent studying Specialized Discipline Courses and various other Analysis and Application Oriented Courses. By the end of the third year, the student would have completed all the named (compulsory) courses of the degree program.
- In the final year, the student spends one semester doing elective courses and the other doing Practice School-II.
- As mentioned earlier, Practice School is optional. A student may even opt for Thesis. Such a student will carry out the Thesis work under the supervision of a faculty member at BITS/other prominent national/international research centres in place of Practice School-II.

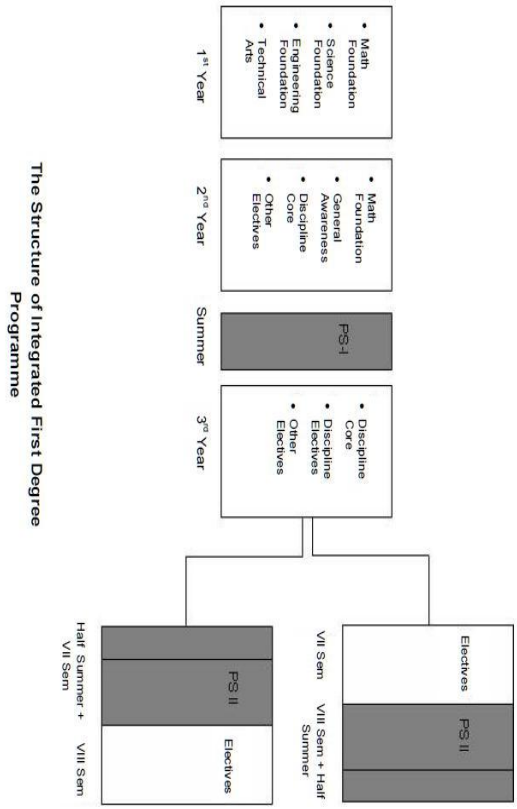
Dual Degree

- A student may be admitted to the Composite Dual Degree Program under which the student simultaneously pursues two degrees.
- Practice School-I appears in the chart at the end of two years in this program. Such a student may opt for PS-II to satisfy the requirements for both the degrees, which will be done in the last two semesters of the program.

Higher Degree

- The program is of two years duration.
- The first three semesters are spent on course work while the last semester is devoted either to Practice School or Dissertation.

The details of the structure of Integrated First Degree Program with Practice School option is shown in the flow chart below.



Practice School-I (PS-I)

Concept

Practice School-I (PS-I) is of eight weeks duration. It is offered during the summer after the students have completed two years of course work. PS-I is primarily exposure-oriented program which is graded for five units as it is an integral part of the curriculum.

Aim

PS-I provides a comprehensive first exposure to professional workplace, to learn organization structure and function, to develop personality traits, and to enhance communication and presentation (oral and written) skills.

Methodology

Orientation (up to four weeks) comprises plant visits and interaction with executives to facilitate the process of learning by observation and discussion, duly aided by the Checklist (an exhaustive list of queries about different aspects of an organization). Projects (often study type, involving collecting data, organizing, analyzing, and presenting data/information) are assigned to promote learning by doing. Components of evaluation include Diary, Quiz, Group Discussion and Presentation to develop regularity, group learning, and communication skills.

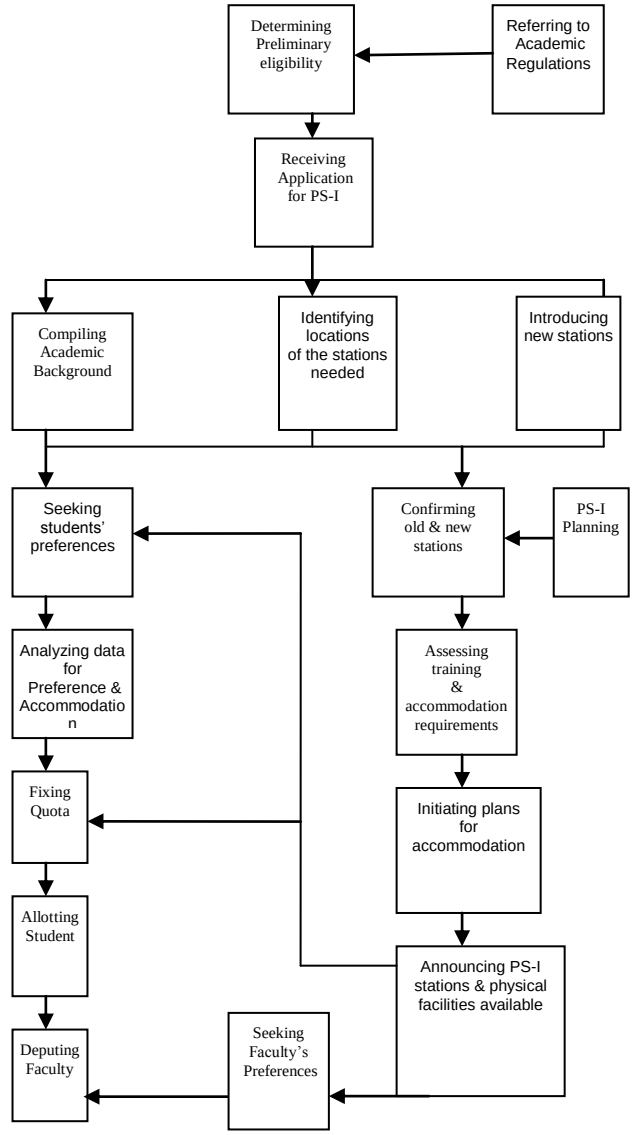
Planning Process

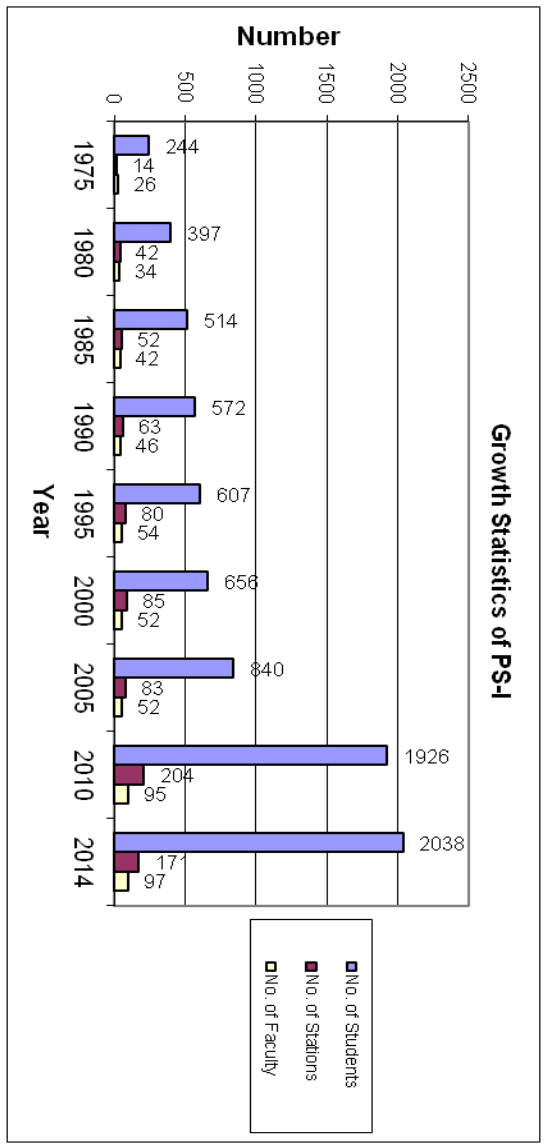
The process begins almost one year before the begining of PS-I. The various steps include (i) deciding the list of eligible students, (ii) carrying out a demographic analysis to establish regionwise targets for the number of stations and seats, (iii) confirming the continuation of existing stations and initiating new stations, (iv) arranging for living accommodation whereever necessary, and (v) deciding about the faculty and student co-instructor needs.

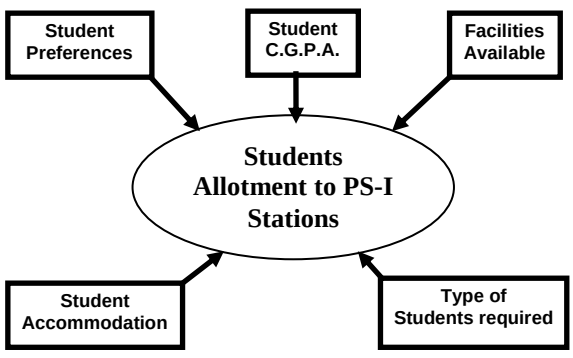
Allotment Process

The list of stations, along with the facilities provided is announced to the students. The students then submit their preference order for the stations, along with information on their accommodation status at the various locations. The allotment is carried out on the basis of the CGPA of the students, keeping their preferences and the availability of accommodation in view, along with any particular requirements specified by the organizations.

The planning and allotment processes are shown in the flow chart below:

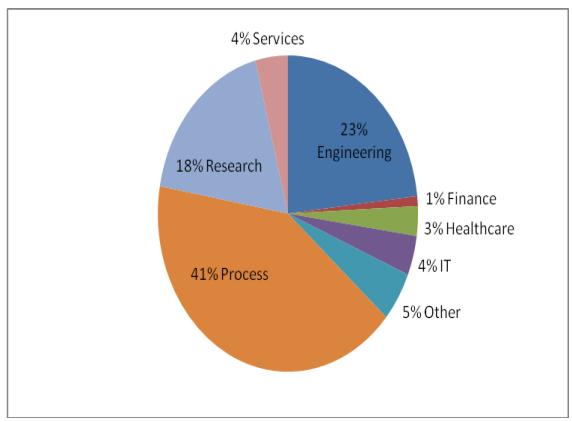






PS-I Allotment Process

Industrywise Student Allocation PS-I 2014



Practice School-II (PS-II)

Concept

Practice School-II, of five and a half months duration, carrying twenty units credit, is operated round the year, from July to December and January to June. This facilitates a continuous stream of well-prepared students to work on developmental projects in industry.

Since the students participate in and contribute to live projects, they are supported by a stipend and/or other facilities such as accommodation, travel reimbursement, etc.

Aim

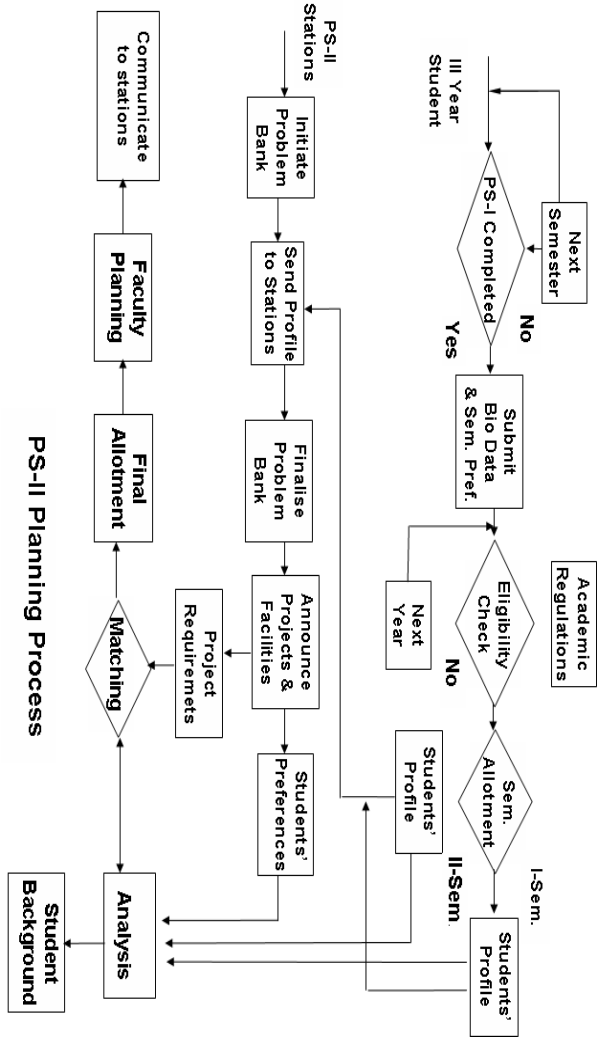
PS-II is directed towards providing an opportunity to students to experience the world of work, by participating in live projects in industry, even before they graduate. Apart from the academic benefits, this also serves to hone their problem solving skills, and build team spirit, initiative, and leadership skills, which makes the eventual transition to the professional world smoother and better.

Methodology

After a brief orientation, the students are involved directly in addressing the predefined problems (generally of multidisciplinary nature) of the host organization. The students are encouraged to work independently, under the technical guidance of a professional expert and the general guidance of the faculty. They are periodically required to defend the technical aspects of their work through written and oral presentations. Emphasis is laid on the importance of teamwork, development of leadership qualities, and the need for effective time management.

Planning Process

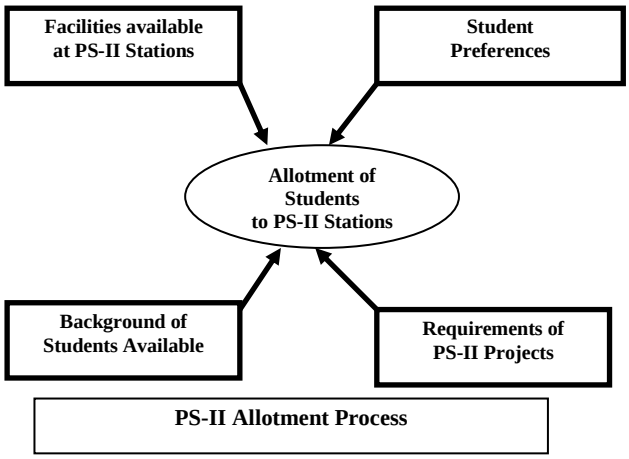
The first step in the planning process is to prepare the list of students who are to register in PS-II in each of the two sessions of the subsequent academic year. Interested dual degree students are likely to be permitted to pursue two semesters of PS-II. Higher Degree student may pursue PS in place of Dissertaion. The next step is to ensure that an adequate number of suitable projects are available from the various organizations (existing and new) to comfortably accommodate all the students. The off-campus faculty member's role is crucial in this part of the process. Another task is to prepare a profile of each student, containing personal data, academic credentials, skills, extra-curricular interests, etc. The flow chart below outlines the planning process.



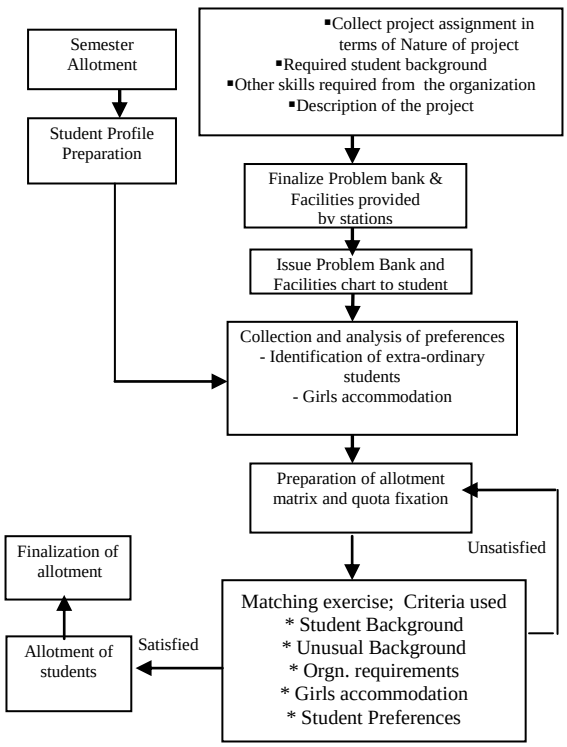
Allotment Process

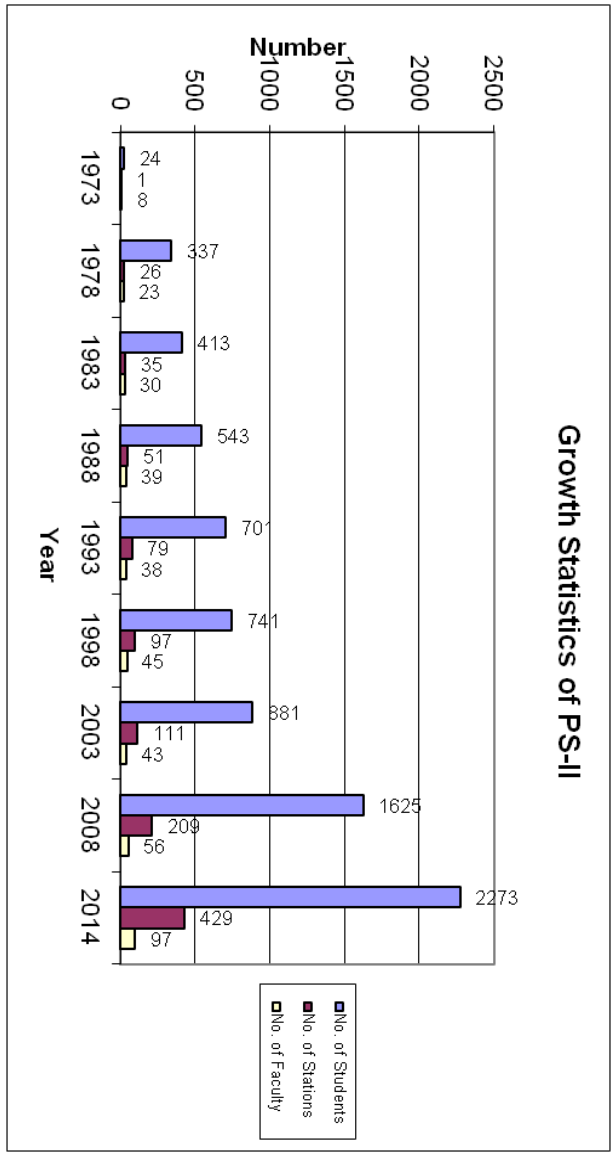
The Problem Bank is a list of assignments from the various organizations, with details of skills and knowledge required. Facilty Chart contains the details of stipend and other support provided by the organizations.

These details are made available to the students. Based on this information, the students submit their preferences for the various projects and organizations. The allotment of students is done by matching the project requirements with students' profiles, keeping the preferences and the merit of the students in view. The details of the allotment process are given below (chart).

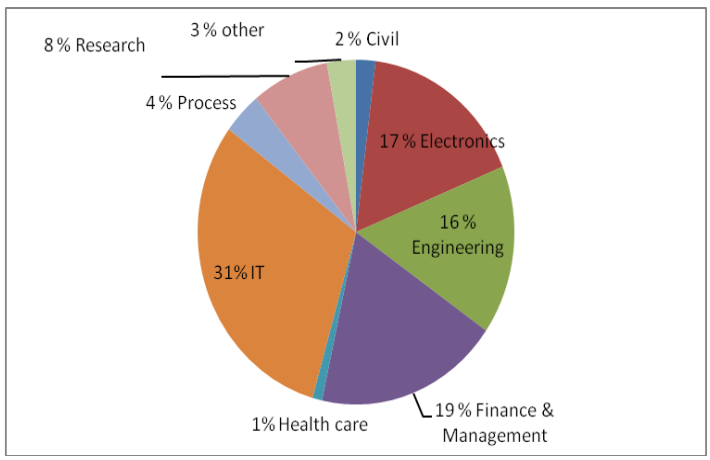


PS-II Allotment Process





Industrywise Student Allocation PS II 2014/15



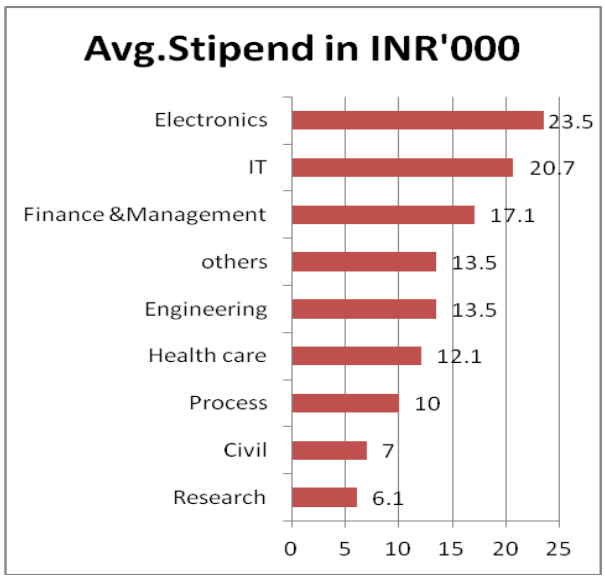
Foreign Stations

Over the years, PS-II has been operated at several locations outside India. These have the added dimension of providing international exposure (both at the professional and the personal levels) to the students. Typically, these organizations provide financial support, adequate to take care of their travel, living expenses, and medical insurance.

The following foreign station have been operated this year.

- Aditya Birla Chemicals, Thailand

The statistics of industry support to PS-II students during I Semester 2014-15 is shown below.



Role of PS-II Faculty

- Act as interface between the Institute and PS Station.
- Generate problem bank for subsequent semester in consultation with organization coordinator.
- Ensure smooth operation by being in constant touch with the students, project mentors, and coordinator.
- Monitor, evaluate, and grade the performance of students.
- Initiate PS activity in new organizations.

Role of Professional Experts

- Identify suitable assignments for the students.
- Provide necessary technical guidance in the execution of the projects.
- Participate in the evaluation of components such as seminar, project reports, and provide inputs to the PS faculty.

Demands of PS

- Enthusiastic, sincere, motivated, and industrious students, with eagerness to learn.
- Cooperation from Industry.
- Additional infrastructure outside the campuses.
- Efficient communication network and information processing systems.
- Committed and dedicated faculty.

Benefits of PS

The success of the PS system is due to the cooperation from industry, the excellence of the students, and the commitment of the Institute and its faculty, with each of the stakeholders also deriving benefits, in addition to the shared expertise, and the participation of industry in the process of university education.

Benefits to Students

- Learning by doing.
- All round development.
- Aid in career planning.
- Experience of professional working conditions.
- Smooth transition from campus to company.

Benefits to Industry

- Steady stream of skilled manpower provides value addition and increased productivity.
- Human Resource Development benefits.
- Conduit for Industrial Partnership.
- Employer Branding.
- Access to expertise from academia.

Benefits to the University

- Inputs to quickly adapt curriculum to match the needs of industry.
- Faculty development.

- Opportunities for research and consultancy.
- Access to industrial expertise and infrastructure.

Success Indicators

- Sustained and increasing demand from industry.
- Increasing stipends to students.
- Length of survival of stations.
- Interest of other Institutions in initiating similar programs.

PS Operational Statistics

Today Practice School programme has established massive linkages across the country, as borne out by the following statistics:

PS-I (Summer 2014)

- No. of Stations : 171
- No. of Students: 2038 (824 from Pilani Campus, 563 from Goa Campus & 651 from Hyderabad Campus)
- No. of Faculty : 97

PS-II (II Semester 2013-14)

- No. of Stations : 244
- No. of Students: 1128 (524 from Pilani Campus, 307 from Goa Campus & 297 from Hyderabad Campus)
- No. of Faculty : 46

PS-II (I Semester 2014-15)

- No. of Stations : 205
- No. of Students: 1144 (451 from Pilani Campus, 324 from Goa Campus & 369 from Hyderabad Campus)
- No. of Faculty: 47

MILESTONES:

- Beginning – 1973
- Opened to all disciplines – 1975
- COPSIMS (Computer Operated Practice School Instruction Monitoring System) – 1985
- First PS station abroad – 1991
- PS for Higher Degree – 1992
- Double semester PS for Dual Degree students – 1992
- Combined PS-I operation for Pilani and Goa campuses – 2006
- Combined PS-II operation for Pilani and Goa campuses – 2007
- WEPSIMS (Web Enabled Practice School Instruction Monitoring System) – 2008
- Combined PS-I operation for Pilani, Goa and Hyderabad campuses – 2010
- Combined PS-II operation for Pilani, Goa and Hyderabad campuses – 2011
- BITS Pilani offers scholarship of Rs. 44,000/- (for the entire duration of PS-II) to selected PS-II students with CGPA 7.00 and above at various research organizations from first semester 2012-2013.

First semester 2017-2018 **Date: 02.08.2017**

COURSE HANDOUT (PART-II)

In addition to part-I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course No. **: BIO F110**
Course Title **: BIOLOGY LABORATORY**
Instructor-in-charge **: SHILPI GARG**

Team of Instructors : B. Vani, Meghna Taare, Shyamantak Mazumdar, Vishalakshi, Aastha Mittal, Sandeep Poonia, Vikas Lamba, Abhilasha Srivastava, Zaiba Hasan Khan, Leena Fageria, Poonam Singh, Nidhi Bub, Subhra Das, Monika M., Monika Paul, Tripti Misra, Neelam Mahala, Pinky, Heena Saini, Vidushi Asati

Course Description:
Analysis and estimation of biomolecules, preparation of temporary slides for microscopic analysis, study of cell structure and division, investigation of catalytic activity of enzyme, physiology of plant and animal systems, diversity of living systems.

Scope and Objective of the course:
The major objective of this course is to offer a hands-on experience on fundamental aspects of practical biology. The student would observe and understand various biological phenomena and also be equipped with some simple techniques which form the basis of research in biology.

Text Book/Manual: Laboratory Manual for Biology, BITS Pilani 2014.

Reference Book: Simon, E.J. et al: Campbell Essential Biology with Physiology (5th Edition, BITS Pilani custom edition). Noida: Perason India Education Services Pvt. Ltd., 2015

Experiment Plan:

Experiment No.	Name of the Experiment	Learning Outcome
Experiment – 1:	Measurement of glucose concentration in the given sample by Folin-Wu's method.	Properties of carbohydrates, their importance to living organisms and associated pathology. Various methods to detect these molecules in pathological samples
Experiment – 2:	Measurement of total protein content in the given sample by Lowry's method.	Proteins: the building blocks; their role in humans; methods to quantify proteins in different samples.
Experiment – 3:	To extract total genomic DNA from banana pulp and learn about	Basic knowledge about the genetic material, principle of its isolation; basic principle of

	agarose gel electrophoresis	separation of macromolecules by electro-phoresis.
Experiment – 4:	Separation of chlorophyll pigments by paper chromatography	Chlorophyll types and structures. Their separation by chromatographic technique.
Experiment – 5:	Measurement of mitotic index and duration of mitosis in the given plant tissue. Observation of various stages of mitosis through readymade slides.	Understanding different phases of cell division, different factors affecting it and preparation of slides to view mitosis in a plant meristematic tissue.
Experiment – 6:	Measurement of haemoglobin content in the human blood and determination of blood group and Rh status.	Blood group incompatibility, genetics behind blood group inheritance, hemoglobin and its importance; Blood typing
Experiment – 7:	To study the effect of the enzyme lactase on milk	Properties of an enzyme and chromogenic detection methods
Experiment – 8:	To study the phenomenon of plasmolysis in onion peel.	Effect of tonicity of a solution on different cell types; osmosis & osmoregulation
Experiment – 9:	Preparation of temporary mount of leaf epidermis to study the structure of stomata and measurement of transpiration rate using Ganong's potometer.	Understanding the role of stomata in controlling transpiartion in plants. Transpiration rate and factors affecting it.
Experiment –10:	Identify and write characteristic features of the given sample slides.	Permanent/ temporary mounts to understand the relationship between structure and function.

Evaluation Scheme:

S. No.	Evaluation component	Duration	Date, time and Venue	Weightage (%)	Nature of component
1.	Day to day Evaluation (Attendance + Performance)	-	Daily Lab	20%	OB
2.	Quiz/ Viva	30 min	TBA	30%	CB
3.	Record	-	Daily Lab	10%	OB
4.	Mid Sem		<TEST_1>		
5.	Comprehensive Exam	2 hrs	<TEST_C>	40%	CB

Note: The order of experiments listed above may change depending on the availability of chemicals, enzymes, and other requirements for a specific experiment.

Notices: Notices will be displayed on Biological Sciences Departmental Notice Board and on Nalanda.

Make up Policy: Make up will be granted only with prior permission in genuine cases such as hospitalization upon production of the relevant documents as proof.

Instructor-in-Charge

01-Aug-2015

First Semester 2015-16

COURSE HANDOUT (PART–II)

In addition to part–I (General Handout for all courses) printed on page 1 of the timetable book, this portion gives further specific details regarding the course.

Course Number : **BIO F111**

Course Title : **GENERAL BIOLOGY**

Instructor-in-Charge : **Shibasish Chowdhury** (shiba@pilani.bits-pilani.ac.in)

Lecture Instructors : Pankaj Kumar Sharma (pankajsharma@pilani.bits-pilani.ac.in)
Rajdeep Chowdhury (rajdeep.chowdhury@pilani.bits-pilani.ac.in)
Vishal Saxena (vishalsaxena@pilani.bits-pilani.ac.in)

Tutorial Instructors : Ashish Runthala (ashishr@pilani.bits-pilani.ac.in)
Chetna Sangwan (p2014404@pilani.bits-pilani.ac.in)
Divya Niveditha (ediviya@gmail.com)
Jyothi Nagraj (nagraj.jyothi@gmail.com)
Panchsheela Nogia (panchsheela.2011@gmail.com)
Parva Sharma (parva.dude@gmail.com)
Prabhat Nath Jha (prabhatjha@pilani.bits-pilani.ac.in)
Ramandeep Kaur (ramanme24@gmail.com)
Sandhya Marathe (sandhya.marathe@pilani.bits-pilani.ac.in)
Sandhya Mehrotra (sandhya@pilani.bits-pilani.ac.in)
Sanjeev Kumar (sanjeev@pilani.bits-pilani.ac.in)
Shilpi Garg (shilpi@pilani.bits-pilani.ac.in)
Sudeshna Mukherjee Chowdhury (sudeshna@pilani.bits-pilani.ac.in)
Uma S Dubey (umas.dubey@gmail.com)
Vidushi Asati (me.asati@gmail.com)

1. Course Outline:

Living systems and their properties; biochemistry and cell biology; primary biochemical/metabolic pathways; introductory genetics; biotechnology and its applications; basic human physiological processes

2. Scope and Objectives:

The course is aimed to provide a broad introduction to the major principles and topics in biology. The relationship of the living organism with its environment at the molecular level is highlighted in line with modern research in biological sciences. By the end of the course, the student would have gained an overall understanding of the core biological principles and wide-ranging applications of biology in industry, medicine and human health.

3. Textbook:

Simon, E.J. *et. al*. Campbell Essential Biology with Physiology (5th edition). Noida: Pearson India Education Services Pvt. Ltd., 2016.

4. Reference Books:

RB1: Enger, E.D., Ross, F.C. and David B. Bailey. Concepts in Biology (14th edition, BITS-Pilani Custom Edition 2012). New Delhi: Tata McGraw-Hill Publishing Company Ltd., 2012.

RB2: Raven, P.H., *et. al.* Biology (9th ed.). Singapore: McGraw-Hill Publishing Company Ltd., 2012.

RB3: Starr, Cecie. Biology: Concepts and Applications (6th ed.). India: Thomson Brooks/Cole, 2007.

5. Lecture Plan:

*Unless specified otherwise, the numbers correspond to chapters from the textbook

Learning Objectives	Topics to be covered	No. of lectures	Chap. No.
Getting introduced to biology and its scope	Biology and scientific method; characteristics of life; diversity of life; two major types of cells	2	1,4
Organic chemistry of living things	Introduction to the macromolecules of cell	2	3
Components of the cell and its internal workings	Introducing microscopy; nucleus and ribosomes; endomembrane system; energy converters; cytoskeleton; ATP and cellular work; membrane function	2	4,5
How cells acquire energy	Energy flow and chemical cycling; cellular respiration - three stages of generating ATPs; process of fermentation	2	6
Processes involved in photosynthesis	Basics of photosynthesis; light reactions; Calvin cycle	2	7

Mechanisms and processes involved in cellular reproduction	The cell cycle and mitosis; meiosis and the origins of genetic variation; consequences of improper cell division (cancer and chromosomal disorders)	3	8
Patterns of inheritance: Mendelian genetics and beyond	Mendel's experimentation and laws; solving problems in Mendelian inheritance; family pedigrees; human disorders; variations of Mendel's laws	3	9
Structure and function of DNA, and viruses	DNA structure and replication; the genetic code; transcription; eukaryotic RNA processing; translation; mutations; viruses	4	10
Genetic regulation, Principles of DNA manipulation and applications of DNA technology	How and why genes are regulated; Introduction to recombinant DNA technology; gene cloning , gel electrophoresis, PCR , Transgenic organism, DNA fingerprinting, reproductive cloning, the genetic basis of cancer	6	11,12
Principles and functions of human digestive, excretory, circulatory and respiratory systems	Unifying concepts of each of the systems; structure of each system and components; disease association with each system	3	13,14, 15
Nervous, sensory and motor systems	Neurons and nerve impulses; central and peripheral nervous systems; senses; skeletal and muscular systems	4	19
Hormonal control in humans	General principles of hormone action and specific examples of glands and hormones	2	17
Concepts of human reproduction and development	Human sexuality spectrum; human male and female reproductive systems, gametogenesis; hormonal control of female reproduction; human development	3	18
The body's defenses (Immune system)	Nonspecific defenses; specific defenses (adaptive immune system); immune disorders	2	16

6. Evaluation Scheme:

#	Evaluation component	Duration	Marks	Date and Time	Remarks
1	Mid-semester Test	1½ hours	40	6/10 4:00 - 5:30 PM	Closed-book type
2	Comprehensive Examination	3 hours	70	4/12 AN	One closed-book and one open-book section
3	Course Quizzes (two)	~ 1 hour each	60		Closed-book type
4	Assignments	Variable	20	Periodically conducted	Some will be in-class; others will be take-home
5	Class participation and interaction	-	10	Periodically assessed	Also see *Attendance Policy* stated in item 8 below.

7. Academic Conduct Policy:

It is expected that all students follow the highest standard of academic practice when participating in any evaluation component. Having a zero–tolerance for academic dishonesty, any case of misconduct, however minor, will be dealt with appropriately. The case may be reported to the Examination Committee for necessary action.

8. Attendance Policy:

Students are expected to be present in all contact sessions - both lectures and tutorials. If a student anticipates absence in a class, he/she is expected to inform the instructor beforehand for availing the benefit of excused absence.

9. Grading Policy:

Award of grades would be guided by the histogram of marks and course average. If a student is absent in any one of components (listed in the *Evaluation Scheme* specified in item 6) entirely, his/her performance in the course may be reported as 'NC' (Not Cleared). The same procedure will be followed for mid-semester and final grading. For a student on the borderline of two grades, the decision on the award of grade will be taken based on progressive improvement he/she has shown throughout the semester, overall course attendance and the tutorial instructor's recommendation (regarding student's promptness in turning in assignments and involvement shown in the class).

10. Make-up Policy:

If a student misses any of the evaluation components due to a genuine reason (serious medical causes leading to hospitalization, personal/family emergencies or absence from classes due to official purposes) there exists a provision to apply for make-up. Prior permission must be taken from the Instructor-in-Charge whenever possible, before applying; otherwise, he must be informed at the earliest after missing the component. The decision to grant make-up is taken by the Instructor-in-Charge in consultation with the instructor team and shall be final.

11. Chamber Consultation:

For any assistance in the course and clarifications, students can meet the instructors who will make themselves available at least one hour per week (chamber consultation hour). The lecture and tutorial instructors will announce their availability for consultation during the first class meeting.

12. Course Announcements and Notices:

All announcements regarding the course will be made in the lecture and tutorial classes. Certain others information (e.g. seating arrangement for exams) will be displayed on the notice boards of the Department of Biological Sciences (3222).

Instructor-in-Charge
BIO F111

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
INSTRUCTION DIVISION
FIRST SEMESTER 2017-2018
Course Handout (Part II)

Date: 02/08/2017

In addition to part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No **: BITS F112**

Course Title **: Technical Report Writing**

Instructor-in-Charge **: KUMAR SANKAR BHATTACHARYA**

Instructors **: Pushp Lata, Sangeeta Sharma, Virendra Singh Nirban, Somdatta Bhattacharya**

1. **Scope and Objective of the course:**

The objective of the course is to help the learners understand the process of communication; develop skills in writing technical reports and present them to an audience effectively.

2. **Textbook:**

Sharma, R.C. and K. Mohan. 2016. *Business Correspondence and Report Writing*. Fifth Edition. New Delhi: Tata McGraw Hill.

3. **Reference Books:**

(i) Raman, Meenakshi and Sangeeta Sharma, 2011. *Technical Communication: Principles and Practice*. Second Edition. New Delhi: Oxford University Press.

(ii) Gerson, Sharon J and Stern M. Gerson. 2000. *Technical Writing: Process and Product.* Third Edition. India: Pearson Education Asia.

(iii) Mohan, Krishna and Meenakshi Raman. 2010. *Advanced Communicative English*. New Delhi: Tata McGraw Hill.

4. Course Plan:

Lec. No	Learning Objectives	Topics to be covered	Ref. Ch. /Sec. No.	Learning Outcome
1-2	To give an insight into the communication process and its importance in day-to-day activities	Communication: Definition and Process	Textbook Ch.1	Understanding the importance, process and types of communication in general, and of business communication in specific. Identifying communication barriers, overcoming them and applying appropriate communication skills across settings, purposes, and audiences.
3	To introduce the elements of effective writing; To give practical hints to make one's writing more effective: choice of words, phrases, and sentences	Elements of Effective Writing- Choice of Words and Phrases	Ch. 19 ; Ref. (i): Ch. 13&14	Developing skills for choosing and using appropriate words and phrases in sentence construction. Identifying and eliminating clichés, circumlocution, redundancy and ambiguity from one's writing to make cohesive, comprehensible and complete paragraphs.
4	To make students conscious of various aspects of writing: sentence construction, sentence length and word order	Effective Writing- Sentence Construction and Length	-----do-----	
5	To provide practice in effective writing	Practice	-----do------	
6	To define technical reports and tell about their characteristic features	Technical Reports	Ch. 15; Ref.(i) Chapter 18	Understanding the importance of technical reports for the professionals and knowing the different formats of reports and their significance.
7-8	To introduce various types of reports; to give practice to prepare routine reports	Types of Reports	Ch. 15; Ref.(i) Chapter 18	
9	To discuss various steps involved in report writing; planning and preparation: from data collection	Preparatory Steps	Ch.17	Understanding and applying the preparatory steps for effective report writing.

	to outline making			
10-11	To discuss various sources for data collection.	Sources of Data	Ch. 17	Learning the primary and secondary methods of data collection and implementing the nuances involved in questionnaire designing.
12-13	To familiarize students with all the methods of data collection	Methods of Data Collection	Ch. 17	
14-15	To provide guidelines for preparing mail questionnaire; to give adequate practice in preparing a questionnaire	Mail Questionnaire	Ch. 17; Ref. (i) Ch.18	
16-19	To give an understanding of various structural elements of a report; to provide practice	Report Structure	Ch. 16	Understanding structural elements of a technical report.
20-21	To give insight into data analysis with the help of illustrations	Data Analysis & Illustrations	Ch. 20	Analyzing data from given illustrations.
22-24	To provide practice in writing reports	Report writing	Ch.22 and 23	Constructing complete technical reports from given information.
25-27	To provide an understanding of shorter reports; when and how to use them	Memo Report & Letter Report	Ch. 23, 26; Ref. (i): Ch.18	Understanding the utility and structural elements of shorter reports like memo and letter reports.
28-29	To make students aware of various aspects of oral presentations of reports; to provide guidelines for effective presentations of reports	Oral Presentation of Reports	Ch. 24	Understanding and applying the rules/methods for effective oral presentation of reports.

After completing this course the students will be able to:

1) Choose ideal form/s of effective oral/written communication.
2) Have basic concepts of technical reports in terms of their structure and function.
3) Collect, understand and analyze various forms of data for effective writing/presentation of reports.
4) Apply acquired knowledge in real life scenarios for report writing and presentation.

5. **Assignments:** The following items to be done as class assignments:

	Topic	Marks	
i)	Assignment 1	30	(30 Minutes OB)
ii)	Report Assignment	40	(90 Minutes OB)

6. Self Learning: Textbook Chap.1; Ref. (iii). Ch.3, 5, 11, 12, 13

7. Evaluation Scheme:

EC No.	Component	Duration	Marks	Date & Time	Nature
1	Mid-Semester	90 min	50	11/10 11:00 - 12:30 PM	CB
2	Comprehensive Exam	2 hours	80	6/12 AN	OB

8. **Chamber Consultation Hours:** To be announced in the class.

9. **Notices:** Notices concerning the course will be on Nalanda.

10. **Makeup Policy**: Makeup will be granted only when the **prior permission** is taken from the instructor. A written request is to be made to the IC through the individual instructor.

INSTRUCTOR-IN-CHARGE
BITS F112

COURSE HANDOUT (PART-II)

Date: 02/08/2017

In addition to part I (General handout for all courses appended to the timetable) this portion gives further details regarding the course.

Course No. : CHEM F110
Course Title : CHEMISTRY LABORATORY
Instructor-in-charge: Inamur Rahaman Laskar

Instructors: Ajay Kumar Sah, Bharti Khungar, Bibhas Ranjan Sarkar, Kiran Bajaj, Madhushree Sarkar, Mrinmoyee Basu, Prashant U. Manohar, Rajeev Sakhuja, Surojit Pande, Aabid Hamid, B Pallavi, Bijoya Das, Chavi Mahala, Dinesh Kumar, Fayaz Baig, Hitesh Kumar Saini, Jagrity Choudhary, Khandagale S Bhausaheb, Nitesh Kumar Nandwana, Rishika Agarwal, Roshan Nazir, Sachin Chaundhary, Santosh Kumari, Saroj, Sunita Kumari

1. AIMS AND LEARNING OBJECTIVE:

The main objective of this course is to educate the students with different aspects of chemistry experiments. The students will carry out set of experiments that will expose the students to experimental methods and to integrate theoretical knowledge and concept to practical experience. Students will also learn the operation of some scientific equipments for performing experiments.

2. TEXT BOOK:

Lab Manual for Chemistry Laboratory: EDD Notes

3. REFERENCE BOOK:

Vogel's textbook of quantitative chemical analysis, Prentice Hall, 2000.

4. COURSE PLAN:

The students will perform the following ten experiments with an emphasis on individual planning and execution of the experiments.

Sl. No.	Experiment Name*
1.	Determination of the pH curve of an acid-base titration
2.	Determination of total hardness of water with EDTA
3.	Identification of some organic compounds
4.	Estimation of copper(II) by iodometry
5.	Synthesis and recrystallization of dibenzalacetone

Serial No.	Experiment Name
6.	Mechanochemical synthesis of a Schiff's base ligand and its Nickel(II) complex – Reaction monitoring using Thin Layer Chromatography
7.	Kinetics of the iodination of acetone
8.	Determination of the concentration equilibrium constant (K_c) of the reaction: $CH_3COOH(aq) + C_2H_5OH(aq) \rightleftarrows CH_3COOC_2H_5(aq) + H_2O(l)$
9.	Dissociation constant of a weak electrolyte by Conductometry
10.	Determination of saponification value of an oil

*** Experiment numbers 1-5 will be carried out in first cycle**
(1-3, Room No.: 3147; 4-5, Room No.: 3101)
Experiment numbers 6-10 will be carried out in second cycle
(6-8, Room No.: 3147; 9-10, Room No.: 3101)

Marks distribution: Punctuality + Safety measures + Cleanliness: 2 + 2 + 1
Laboratory Conduct: 10
Record maintenance: 10

5. EVALUATION:

Component	Weightage %	Date and Time
Laboratory Work and Reports (225)	75%	Continuous
Comprehensive Examination (75)	25%	

6. IMPORTANT NOTES: Students must **submit laboratory report** for each experiment in the **next lab-class**. Students **must read the experiments** from the lab-manual before coming to the lab.

7. MAKE-UP: Make-up in laboratory course is generally less feasible but one buffer experiment will be offered for the semester. Further make-ups may require rigorous validation as per the institute guidelines.

8. NOTICE: Notices concerning this course will be displayed on **Nalanda/ Chemistry Department notice board** only.

Inamur Rahaman Laskar
Instructor-In-Charge
CHEM F110

Course Handout (Part II)

Dated: 2/ 8 /2017

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : **EEE F111**
Course Title : **ELECTRICAL SCIENCES**
Instructor-in-charge : **H.D.Mathur**
Team of Instructors : **Abhijit R Asati, Pawan K Ajmera, K K Gupta, Arnab Hazra, Mahesh Angira, Rahul Singhal, Kavindra Kandpal, Anantha Krishna Chintanpalli, Harshavardhan S**

1. **Course Description:** Course covers Basics of electrical circuit elements, Kirchhoff's law, Network analysis and Network theorems, Transient analysis of first order and second order circuits, Semiconductors and diodes, Basic operation and characterization of transistors (BJT and FET), Basics of operational amplifiers and its application, AC circuit analysis, Frequency response, Filters, Magnetic circuits and B-H curves, Transformer, Overview of electrical machines.

2. **Scope and Objective of the course:** The principal objective of this course is to teach the principles of three different aspects of electrical sciences (1) Circuits (2) Electronics and (3) Electro magnetics to the student composed of mixed disciplines.

3. **Text Books:**
Leonard S. Bobrow and Navneet Gupta, Foundations of Electrical Engineering, Oxford University Press, Asian Edition, 2015.
Reference Books:
. 1. Allan R Hambley, Electrical Engineering: Principles and Applications; 5th Edition, Prentice Hall of India, 2011.

4. **Course Plan:**

Module No.	Coverage	Ref.(TB)	Learning Outcome
1	L1.1 Basic circuit elements (Voltage,	1.1 -1.7	To develop understanding about basic circuit elements and the laws for solving basic electrical circuits
	L1.2 current sources, and Resistors), Kirchhoff's law (KCL and KVL),		
	L1.3 Current division, voltage division, instantaneous power, Inductors, Capacitor		
2	L2.1 Independent and Dependent sources, Source transformation	1.8, 2.4	To analyse and study the types of sources in network analysis
3	L3.1 Nodal analysis and Mesh analysis	2.1- 2.3	To study circuit analysis techniques
4	L4.1 Thevenin's Theorem	2.4,2.6	To use and understand applications of various network theorems in simplifying electrical circuits.
	L4.2 Norton's Theorem		
	L4.3 Maximum Power Transfer Theorem and Superposition		
5	L5.1 Transient response of first order circuit (Natural response)	3.2-3.5	To understand the order of the circuit and study its transient and

	L5.2 Transient response of First order circuit (complete response)		steady state response.
	L5.3 Transient response of second order circuit (Natural response)		
	L5.4 Transient response of second order circuit (complete response)		
6	L6.1 Time-domain analysis, Waveforms, power factor,	4.1,4.2, 4.3	To study about phasors and phasor algebra.
	L6.2 Phasor representation of alternating quantities, j operator and Phasor algebra, frequency-domain analysis		
7	L7.1 Type of power in electrical system	4.4,4.5	To study the concept of power in AC circuits and their significance in real life.
	L7.2 Average Power, apparent power and problems based on them.		
	L7.3 complex power and problems based on it.		
8	L8.1 Three phase Circuits (Y connections)	4.6	To study the poly-phase circuits and their application in real world.
	L8.2 Three phase Circuits (Δ connections)		
9	L9.1 Frequency response, Filters (Low Pass, High Pass and Band Pass)	5.1,5.2	To study the frequency response and resonance phenomenon in electrical systems. Filters and their use in practical electrical circuits.
	L9.2 Resonance		
	L9.3 Quality factor		
10	L10.1 Basics of Semiconductors	6.2(partly), 6.3, 6.4	To study basics of semiconductors and diodes and their application in various electronic circuits.
	L10.2 PN junction, Junction diode,		
	L10.3 Ideal diode and applications (rectifiers and clippers)		
11	L11.1 Zener diodes and its model	6.6	To study the breakdown mechanisms in semiconductor diodes
	L11.2 Zener diode application as voltage regulation and clipper)		
12	L12.1 Basic operation of BJT	7.1-7.3	To study the construction and operation of Bipolar Junction Transistors
	L12.2 Characteristics of BJT		
	L12.3 Problem on various BJT circuits		
13	L13.1 Basic operation and characteristics of JFET	8.1,8.2, 10.1	To study the types, construction, characteristic and operation of Field Effect Transistors To study circuit analysis techniques with OPAMP
	L13.2 Basic operation and characteristics of MOSFET		
	L13.3 Problem on various JFET and MOSFET circuits		
	L13.4 Basics of operational amplifier and its application		
14	L14.1 Analogy between electrical & magnetic circuits, B-H curves,	13.1, 13.2 (partly) 13.3-13.7 13.8-13.9 15.1 -	To develop the fundamentals of electromechanics, the magnetic effects associated with transformer, physical structure and basic working of DC/ AC machines
	L14.2 Hysteresis, Electromagnetic Induction, Magnetic coupling		
	L14.3 Lenz's law, Transformers,		
	L14.4 Ideal transformer and their uses		
	L14.5 Basics of rotating machines		

		15.2 (Partly)	
	14.6 Types and characteristics of rotating machines		

5. Evaluation Scheme:

S No.	Evaluation Component	Duration	Marks (300)	Weightage	Date & Time	Nature of Component
1.	Mid-Sem Test	90 min.	105	35%	10/10 11:00 - 12:30 PM	Open Book
2.	Surprise quiz	20 min	60	20%	During Common Hour	Closed Book
3.	Comprehensive	3 hrs.	135	45%	4/12 AN	Closed Book

6. **Chamber Consultation Hour:** Will be displayed on Nalanda.
7. **Course Notices**: All notices of this course will be displayed on the **Nalanda only**
8. **Make–up Examination:** No make-up will be given for surprise quizzes, however for other components; make-up will be given **ONLY** in cases of **sickness (hospitalization)** or **urgency** for going out of station. In such case student must produce the sufficient proof or must have taken the prior permission from the IC.

Instructor-in-Charge
EEE F111