University of Mumbai

No. AAMS_UGS/ICC/2022-23/ 176

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to the syllabus uploaded by Academic Authority Meetings & Services which was accepted by the Academic Council at its meeting held on 14th July, 2016 **vide** item No. 4.33 relating to the revised syllabus for M.E. (Mechanical) Thermal Engineering.

You are hereby informed that the recommendations made by the Board of Studies in **Mechanical Engineering** at its meeting held on 31st May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 **vide** item No. 6.50 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.50 (R) and that in accordance therewith, the revised syllabus of **M.E. (Thermal Engineering) (Sem.- I to IV) (CBCS) (REV-2022 Scheme)**, has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

(Prof. Sunil Bhirud)
I/c Registrar

MUMBAI – 400 032
19th November, 2022

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.50 (R)/11/07/2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Mechanical Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC – 11 July, 2022
Item No. – 6.50 (R)

University of Mumbai

Revised Syllabus for

M.E.

(Thermal Engineering)

Semester – (I to IV)

(Choice Based Credit System)

(With effect from the academic year 2022-23)

University of Mumbai

O: _____ Title of Course	M.E. (Thermal Engineering)
O: _____ Eligibility	Ordinance 0.5134
R: _____ Passing Marks	45%
No. of years/Semesters:	4 semesters
Level:	P.G. / ~~U.G./ Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	~~New~~ / Revised
To be implemented from Academic Year :	With effect from Academic Year : 2022-23

Dr. Vivek Sunnapwar
Chairman
of Board of Studies in Mechanical Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology

Preamble

Education in engineering is growing in India and is expected to increase by a factor of several in the near future. The current situation presents a significant challenge in terms of ensuring quality to stakeholders while expanding. To face this challenge, the problem of quality must be addressed, debated, and progressed in a methodical manner. Accreditation is the primary form of quality assurance in higher education, and it signifies that the institution or programme of study is committed to meeting certain minimum stated requirements and is available to external assessment in order to get recognition. The main goal of this accrediting procedure is to assess the outcomes of the programme being evaluated. Program outcomes are a collection of skills and information that a student will possess upon completion of the programme. In keeping with this, the University of Mumbai's Faculty of Science and Technology has taken the lead in implementing the principle of outcome-based education into the curriculum building process.

We are pleased to report that the Postgraduate Program Educational Objectives were completed in a brainstorming session attended by more than 20 members from the University's associated institutes. They were either department heads or senior faculty from the Mechanical Engineering Department. The Program Educational Objectives finalized for the postgraduate program in Mechanical Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals.

2. To prepare the Learner to use modern tools effectively in order to solve real life problems.

3. To prepare the Learner for a successful career in Indian and Multinational Organisations

4. To encourage and motivate the Learner in the art of self-learning.

5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner’s thought process.

In addition to the aforementioned, linked Institutes may add 2 to 3 additional programme instructional objectives of their own. In addition to Program Educational Objectives, each course in a postgraduate program's curriculum includes objectives and expected outcomes from the perspective of the learner to support the idea of outcome-based education. We are convinced that even a tiny move in the correct manner will go a long way toward ensuring that the main stakeholders receive high-quality education.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

To tackle the challenge of assuring engineering education excellence, the problem of quality must be addressed, debated, and progressed in a methodical manner. Accreditation is the primary way of ensuring the quality of higher education. The main goal of the certification procedure is to determine how good a company is. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development.

Faculty of Science and Technology, University of Mumbai, in one of its meetings collectively resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs), give freedom to Affiliated Institutes to add few (PEOs), course objectives course outcomes to be clearly defined for each course, so that all faculty members in linked institutes are aware of the depth of approach to the subject to be given, so improving the learning process of students It was also decided that while changing the curriculum, the most senior academics from institutions and industry specialists should be included.

We are happy to state that the Board of studies has adhered to the resolutions passed by Faculty of Technology and developed curriculum accordingly. In addition to outcome-based education, Choice Based Credit System is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System allows for a much-needed shift in education focus from teacher-centric to learner-centric, since the workload estimate is based on time spent learning rather than teaching. It also emphasises constant evaluation, which will improve educational quality. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes. Faculty of Technology has devised a transparent credit assignment policy, adopting a ten-point scale to grade learner's performance. REV-2022 scheme is implemented for Master of Engineering from the academic year 2022-2023.

We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar : Chairman
Dr. S. M. Khot : Member
Dr. V. M. Phalle : Member
Dr. Siddappa Bhusnoor : Member
Dr. S.S. Pawar : Member
Dr. Sanjay U. Bokade : Member
Dr. Dhanraj Tambuskar : Member
Dr. V. B. Tungikar : Member
Dr. K.P. Karunakaran : Member
Dr. S. S. Thipse : Member
Dr. Milind Deshmukh : Member

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
TEC101	Advanced Heat Transfer	3	--	--	3	--	--	3
TEC102	Numerical Methods and Computational Techniques	3		--	3		--	3
TEPE101X	Program Elective 1	3	--	--	3	--	--	3
TEPE102X	Program Elective 2	3	--	--	3	--	--	3
TEIE101X	Institute Elective 1	3	--	--	3	--	--	3
TEL101	Renewable Energy (Program Lab-I)	--	2	--	--	1	--	1
TESBL101	Simulation of Thermal Systems (Skill Based Lab-I)	--	4$	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
TEC101	Advanced Heat Transfer	20	20	20	80	3	--	--	100
TEC102	Numerical Methods and Computational Techniques	20	20	20	80	3	--	--	100
TEPE101X	Program Elective 1	20	20	20	80	3	--	--	100
TEPE102X	Program Elective 2	20	20	20	80	3	--	--	100
TEIE101X	Institute Elective 1	20	20	20	80	3	--	--	100
TEL101	Renewable Energy (Program Lab-I)	--	--	--	--	--	25	25	50
TESBL101	Simulation of Thermal Systems (Skill Based Lab-I)	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	**--**	**75**	**75**	**650**

Program Elective 1		Program Elective 2	
Course Code	**Program Elective**	**Course Code**	**Program Elective**
TEPE1011	Solar Thermal Engineering	TEPE1021	Advanced Turbo Machinery
TEPE1012	Cogeneration and Waste Heat Recovery Systems	TEPE1022	Energy Audit and Management
TEPE1013	Alternative Fuels	TEPE1023	Advanced Fluid Mechanics

Institute Elective 1	
Course Code	**Institute Elective**
TEIE1011	Product Lifecycle Management
TEIE1012	Reliability Engineering
TEIE1013	Management Information System
TEIE1014	Design of Experiments
TEIE1015	Operation Research
TEIE1016	Disaster Management and Mitigation Measures
TEIE1017	Research Methodology

Semester II

Course Code	Course Name	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
TEC201	Refrigeration and Air conditioning System Design	3	--	--	3	--	--	3
TEC202	Computational Fluid Dynamics	3		--	3		--	3
TEPE201X	Program Elective 3	3	--	--	3	--	--	3
TEPE202X	Program Elective 4	3	--	--	3	--	--	3
TEIE201X	Institute Elective 2	3	--	--	3	--	--	3
TEL201	Computational Fluid Dynamics (Program Lab-II)	--	2	--	--	1	--	1
TESBL201	Virtual Instrumentation & Laboratory (Skill Based Lab-II)	--	4$	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
TEC201	Refrigeration and Airconditioning System Design	20	20	20	80	3	--	--	100
TEC202	Computational Fluid Dynamics	20	20	20	80	3	--	--	100
TEPE201X	Program Elective 3	20	20	20	80	3	--	--	100
TEPE202X	Program Elective 4	20	20	20	80	3	--	--	100
TEIE201X	Institute Elective 2	20	20	20	80	3	--	--	100
TEL201	Computational Fluid Dynamics (Program Lab-II)	--	--	--	--	--	25	25	50
TESBL201	Virtual Instrumentation & Laboratory (Skill Based Lab-II)	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	**--**	**75**	**75**	**650**

Note 1: Skill Based Lab- I and II are focused on the learning through experience. SBL shall facilitate the learner to acquire the fundamentals of practical engineering in his or her specialization in a project-oriented environment. The learning through skill-based labs can be useful in facilitating their research work and hence useful in early completion of their dissertation work.

Program Elective 3		Program Elective 4	
Course Code	**Program Elective**	**Course Code**	**Program Elective**
TEPE2011	Cryogenics	TEPE2021	Non-Conventional Power Plants
TEPE2012	Internal Combustion Engine Design	TEPE2022	Steam and Gas Turbines
TEPE2013	Modeling and Analysis in Thermal Engineering	TEPE2023	Heat Exchanger Design and Performance

Institute Elective 2	
Course Code	**Institute Elective**
TEIE2011	Project Management
TEIE2012	Finance Management
TEIE2013	Entrepreneurship Development and Management
TEIE2014	Human Resource Management
TEIE2015	Professional Ethics and CSR
TEIE2016	IPR and Patenting
TEIE2017	Digital Business Management
TEIE2018	Environmental Management

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
TEMP301	Major Project: Dissertation -I	--	20	--	--	10	--	10
Total		**00**	**20**	**00**	**00**	**10**	**--**	**10**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
TEMP301	Major Project: Dissertation -I	--	--	--	--	--	100	--	100
Total		**--**	**--**	**--**	**--**	**--**	**100**	**--**	**100**

Online Credit Courses

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
TEOCC301	Online Credit Course - I	--	--	--	--	--	--	3
TEOCC301	Online Credit Course - II	--	--	--	--	--	--	3
Total		**--**	**--**	**--**	**00**	**00**	**00**	**06**

Note 2: It is mandatory to complete the Online Credit Courses (OCC)available on NPTEL / Swayam /MOOC or similar platform approved by UoM. These two courses shall be completed in any semester I or II or III, but not later end of the Semester III. University shall make a provision that credits earned with OCC- I and OCC-II shall be accounted in the third semester grade-sheetwith actual names of courses. The learner shall be allowed to take up these courses from his or her institute or organisation/ industry where his / her major project is carried out. The students shall complete the courses and shall qualify the exam conducted by the respective authorities/ instructor from the platform. The fees for any such courses and the corresponding examination shall be borne by the learner.

Online Credit Course – I

The learner shall opt for the course in the domain of Research Methodology **or**Research & Publication Ethicsor IPR. The opted course shall be of 3 credits of equivalent number of weeks.

Online Credit Course –II

The learner shall opt for the course recommended by Faculty Advisor/ Project Supervisor from the institute. The opted course shall be of 3 credits of equivalent number of weeks.

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
TEMP401	Major Project : Dissertation -II	--	32	--	--	16	--	16
Total		**--**	**32**	**--**	**--**	**16**	**--**	**16**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
TEMP401	Major Project : Dissertation -II	--	--	--	--	--	100	100	200
Total		**--**	**--**	**--**	**--**	**--**	**100**	**100**	**200**

Total Credits: 68

Note 3: The Dissertation -II submission shall not be permitted till thelearner completes all the requirements ME course.

Note 4: The contact hours for the calculation of load of the teacher for Major Project are as follows:
Major Project Dissertation I and II - 02 Hour / week / student

Guidelines for Dissertation-I

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format. Guidelines for Assessment of Dissertation-I.

Dissertation-I should be assessed based on following points

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope Dissertation-I should be assessed through a presentation by a panel of Internal examiners and external examiner appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted or learner contribution
- Validation of results
- Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred National/International conference/Journal of repute.

Dissertation II should be assessed by internal and External Examiners appointed by theUniversity of Mumbai.

Course Code	Course Name	Credits
TEC101	**Advanced Heat Transfer**	**3**
	Objectives 1. Impart the advances knowledge of heat transfer. 2. Get analytical solutions for Dimensional steady and transient heat conduction problems. 3. Deep understanding on the governing equations for convection heat transfer and itsapplication. 4. Understand the boiling and condensation mechanism. **Outcomes: Learner will be able to…** 1. Understand applications of classical heat transfer to practical problems. 2. Exhibit analytical and model synthesis skills needed to apply the fundamentals to a wide variety of complex engineering problems. 3. Design systems requiring significant consideration of heat transfer.	
Module	**Detailed Contents**	**Hrs.**
01	Introduction to basic laws and general heat conduction equations, boundary and initial conditions. Multidimensional heat transfer. Concept of variable thermal conductivity in plane wall. Thermal contact resistance. Three-dimensional heat conduction. Heat transfer enhancement techniques. Active and passive techniques.	07
02	Heat transfer in common configurations, concept of conduction shape factor. Conduction in porous media. Transient heat conduction: Lumped system analysis. Introduction to transient heat conduction in large plane wall and cylinders withspatial effects.	06
03	Natural Convection heat transfer: Solution of convection equation for flat plate. Grashof number. Natural convection over vertical plate, horizontal plate, vertical and horizontal cylinder, spheres. Natural convection cooling of finned surfaces, vertical PCBs. Natural convection inside vertical and horizontal rectangular enclosures, concentric cylinders.	07
04	Forced Convection: Laminar forced convection in long tube, correlations for laminar forced convection. Correlations for coiled tubes, Empirical correlations for turbulent forced convection for circular ducts and tubes.	06
05	Introduction to flow boiling, flow patterns in vertical and horizontal tubes, Correlations, post dry-out heat transfer. Condensation: heat transfer correlation for condensation heat transfer for vertical plate. Film condensation inside horizontal tubes and horizontal tubes. Radiation heat transfer: radiation in gases, mean beam length, radiation network forabsorbing and transmitting medium.	06
06	Numerical methods in heat conduction: Necessity, Limitations, Finite difference formulation of differential equations, Explicit, Crank Nicolson and Fully implicit schemes of Discretization, finite difference formulation of one-dimensional heat conduction in a plane wall using the energy balance approach, Boundary conditions. Solution of problems on large plane walls and triangular fins, Control volume formulation, Steady one-dimensional convection problems	07

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test (on minimum Two Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Guidelines for setting up the question paper:

1. Minimum 80% syllabus should be covered in question papers of end semester examination. In question paper weightage of each module willbe proportional to number of respective lecture hours as mention in the syllabus.
2. Question paper will comprise of total six questions
3. All question carries equal marks
4. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3then part (b) will be from any module other than module 3)
5. Only Four questions need to be solved.

References:

1. Yunus A Cengel and Afgin J Ghajar, Heat and Mass Transfer: Fundamentals andApplications, 5th Ed., McGraw-Hill Education
2. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley &Sons
3. S.P. Sukhatme, Heat Transfer, University Press
4. Patankar. S.V.,Numerical heat Transfer and Fluid flow, Hemisphere PublishingCorporation
5. J P Holman, Heat Transfer, 9th Ed., McGraw Hill, Int.
6. Frank Kreith & John S Bohn, Principles of Heat Transfer, Cengage Learning India PvtLtd.
7. C P Kothandaraman, Fundamentals of Heat and Mass Transfer, New Age InternationalPublishers.
8. Bejan A and Kraus A, Heat Transfer Handbook, John Wiley & Sons
9. Bejan A, Convective Heat Transfer, Wiley, Third edition, 2004

Course Code	Course Name	Credits
TEC102	**Numerical Methods and Computational Techniques**	**3**
	Objectives 1. To impart knowledge on numerical methods that will come in handy to solve numericallythe problems that arise in Thermal Engineering. 2. To serve as a precursor for future research Outcomes: Learner will be able to… 1. Able to identify and use suitable numerical method to address live engineering problem	
Module	**Detailed Contents**	**Hrs.**
01	Algebraic and transcendental equation: Bisection method, Fixed point, Regula-Falsi method, Muller's method, Newton-Raphson method, Rate of convergence, Merits and demerits of methods	07
02	Simultaneous Linear Equations: Motivation, Gauss elimination, Pivoting, Factoring, Solution accuracy, Iterative methods, Jacobi method, Relaxation method.	06
03	Interpolation and Curve Fitting: Motivation, Polynomial forms, Linear interpolation, Lagrangean interpolation, Newton interpolation, Spline interpolation, Chebyshev Interpolation, Regression analysis, Fitting linear equations, Least-square method, Fitting transcendental equations, Polynomial functions, Multiple linear regression.	07
04	Numerical integration and differentiation: Maxima and Minima, Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Weddle's rule, Euler-Maclaurin's formula, Gaussian Quadrature formula	06
05	Numerical solution of ordinary differential equation: Picard's Method of successiveapproximation, Euler's Method, Modified Euler's Method, Runge-Kutta Methods	06
06	Boundary-value and Eigen-value Problem: Motivation, Shooting method, Finite difference method, Finite volume method, Polynomial method, Power method, Elliptic, Parabolic and Hyperbolic Partial Differential Equations.	07

Students have to develop a programme to cater to a real life thermal engineering problem based onany of the numerical method mentioned in the syllabus as a part of Test

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test (on minimum Two Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Guidelines for setting up the question paper:

1. Minimum 80% syllabus should be covered in question papers of end semester examination. In question paper weightage of each module willbe proportional to number of respective lecture hours as mention in the syllabus.
2. Question paper will comprise of total six questions
3. All question carries equal marks
4. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3then part (b) will be from any module other than module 3)
5. Only Four questions need to be solved.

References:

1. Manish Goyal,Computer Based Numerical and Statistical Techniques, Laxmi Publications
2. (P) Ltd, New Delhi
3. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice-Hall of India(P) Ltd, New Delhi
4. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New Age International (P) Ltd
5. Salvadori M G, Baron M L, Numerical Methods in Engineering, Prentics-Hall
6. Chapra S C, Candle R P,Numerical Methods for Engineers, 2nd Ed, NcGraw-Hill, New York
7. Gerald C F, Wheatley P O, Applied Numerical Analysis, 6th edition, Pearson Education, 1999
8. Cheney W., Kincaid D., Numerical Mathematics and Computing, 5th edition, Thomson /Brooks Cole, 2004.
9. William F. Ames, Numerical Methods for Partial Differential Equations, 2nd Edition, Academic Press, 1977.

Course Code	Course Name	Credits
TEPE1011	**Solar Thermal Engineering**	**3**
	Objectives: 1. To learn the characteristics and world distribution of solar radiation 2. To learn the solar radiation and measurement techniques. 3. To learn about types of Solar cell and its ratings. 4. To learn the solar thermal system; an energy efficient approach. 5. To learn the fundamentals of thermal and direct conversion of solar energy to power. Outcomes: Upon successful completion of this course, the learner will be able to 1. Get knowledge of the competing demands and requirements of the various solar operated electrical power network. 2. Understand how renewable generation and distributed storage interacts with and is integrated into the power network. 3. Explain the technical and physical principles of solar thermal systems, 4. Understand analytical models and use these to evaluate thermal performance of system.	
Module	**Details**	**Hours**
1.	ENERGY RESOURCES AND SOLAR SPECTRUM: - World energy resources - Indian energy scenario - Environmental aspects of energy utilization. Renewable energy resources and their importance - Global solar resources. Solar spectrum – Electromagnetic spectrum, basic laws of radiation. Physics of the Sun - Energy balance of the earth, energy flux, solar constant for earth, greenhouse effect.	06
2.	SOLAR RADIATION AND MEASUREMENT: - Solar radiation on the earth surface - Extra-terrestrial radiation characteristics, Terrestrial radiation, solar insolation, spectral energy distribution of solar radiation. Depletion of solar radiation - Absorption, scattering. Beam radiation, diffuse and Global radiation. Measurement of solar radiation – Pyranometer, Pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E).	08
3.	SOLAR RADIATION GEOMETRY AND CALCULATIONS:-Solar radiation geometry - Earth-Sun angles – Solar angles. Calculation of angle of incidence - Surface facing due south, horizontal, inclined surface and vertical surface. Solar day length – Sun path diagram – Shadow determination. Estimation of Sunshine hours at different places in India. Calculation of total solar radiation on horizontal and tilted surfaces. Prediction of solar radiation availability.	08
4.	TURBULENT FORCED CONVECTIVE HEAT TRANSFER Momentum and energy equations, turbulent boundary layer heat transfer – Mixing length concepts, turbulent model – K - ε model, Analogy between heat and momentum transfer – Reynolds, Colburn and Von Karman. High speed flows. RADIATION - Gases and vapours. Solar radiation – Sky radiations, solar	10

	radiation through fenestrations – Estimations. PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS:- Condensation and boiling – Pool and flow boiling, solidification and melting. Heat exchanger - ε - NTU approach and design procedure, compact heat exchanger.	
5.	SOLAR THERMAL ENERGY CONVERSION:- Thermodynamic cycles – Carnot – Organic, reheat, regeneration and supercritical Rankine cycles - Brayton cycle – Stirling cycle – Binary cycles – Combined cycles. Solar thermal power plants - Parabolic trough system, distributed collector, hybrid solar-gas power plants, solar pond based electric-power plant, central tower receiver power plant.	08
6.	SOLAR ELECTRICAL ENERGY CONVERSION:-Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Solar cell ratings, Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants.	08

Course Code	Course Name	Credits
TEPE1012	**Cogeneration and Waste Heat Recovery Systems**	**3**
	Objectives 1. To understand cogeneration and waste heat recovery techniques 2. Learn to check viability of cogeneration and waste heat recovery 3. To summaries economics of such systems **Outcomes:** Learner will be able to… 1. Estimate and quantify available waste heat 2. Tap opportunities of waste heat recovery 3. Understand economics of cogeneration and waste heat recovery systems	
Module	**Detailed Contents**	**Hrs.**
01	**COGENERATION:** Introduction - Principles of Thermodynamics - Combined Cycles-Topping -Bottoming - Organic Rankine Cycles - Advantages of Cogeneration Technology	**6**
02	**APPLICATION & TECHNO ECONOMICS OF COGENERATION:** Cogeneration Application in various process industries. Sizing of waste heat boilers - Performance calculations, Part load characteristics selection of Cogeneration Technologies – Financial considerations - Operating and Investments - Costs of Cogeneration	7
03	**WASTE HEAT RECOVERY:** Introduction - Principles of Thermodynamics and Second Law - sources of Waste Heat recovery - Diesel engines and Power Plant etc. Vapour Absorption systems working on waste heat	6
04	**WASTE HEAT RECOVERY SYSTEMS:** Recuperators - Regenerators - economizers - Plate Heat Exchangers - Waste Heat Boilers-Classification, Location, Service Conditions, Design Considerations, Unfired combined Cycle - supplementary fired combined cycle - fired combined cycle - fluidised bed heat exchangers - heat pipe exchangers - heat pumps - thermic fluid heaters	7
05	**APPLICATIONS & TECHNO ECONOMICS of Waste Heat Recovery Systems:** Applications in industries, selection of waste heat recovery technologies - financial considerations, saving potentials of different waste heat sources - operations and investment costs of waste heat recovery	7
06	**Introduction to tri-generation and quad-generation**	6

Course Code	Course Name	Credits
TEPE1013	**Alternative Fuels**	**3**
	Objectives 1. To understand socioeconomic and environment aspects of alternative fuels. 2. To get knowledge of production of alternative fuels. 3. To learn the need for fuel substitution and subsequent benefits. **Outcomes:** Learner will be able to… 1. To distinguish between types of alternative fuels. 2. To determine the quality of biofuels. 3. To analyse the impact of alternative fuels on environment.	
Module	**Detailed Contents**	**Hrs.**
01	**Fossil Fuels to Alternative Fuels** Reserves of Fossil fuels in India and globe, Disadvantages of Fossil fuels, Need ofAlternative fuels, Types, Advantages, Sources of Alternative fuels.	**6**
02	**Advanced Liquid Biofuels** Raw material for biofuel production, Biomass and Waste, First and next generation biofuels, Conversion of lignocellulosic, algal biomass, and waste into biofuels and chemicals, Production of Biodiesel, Bio alcohol, Jatropha Fuel Applications.	7
03	**Advanced Gaseous fuels** Bio-CNG from sugarcane, Synthetic gas SynGas, generation of SynGas throughplasma gasification of plastic waste, Applications.	7
04	**Hydrogen Technology** Hydrogen as Alternative fuel, Hydrogen storage, hydrogen liquefaction, ortho andpara hydrogen, Non-fossil Natural gas and methane, Applications.	6
05	**Fuel Cells** Principle & operation of Fuel cells, Thermodynamics of fuel cells, types of fuel cells, comparison of fuel cell technologies, stack configurations and fuel cellsystems, Applications.	7
06	**Alternative Fuels and Environmental Impact** Climate change, Benefits of alternative fuel to environment, Environmental impactassessment.	6

Course Code	Course Name	Credits
TEPE1021	**Advanced Turbo Machinery**	**3**
	Objectives 1. Study basic concepts and principles of turbo machinery 2. Learn performance analysis of centrifugal as well as axial machines like fans, blowers andcompressors **Outcomes:** Learner will be able to… 1. Read and understand performance characteristic curves of various turbo machines 2. Design blowers and fans for specified applications 3. Identify suitable control and testing methods for blowers and fans	
Module	**Detailed Contents**	**Hrs.**
01	**Basic concepts of turbo machines:** Definition of Turbo machine, classification; Euler's pump equation and Euler's turbine equation, dimensional analysis applied to Hydraulic machines and compressible flow machines.	6
02	**Principles of turbo machinery:** Transfer of energy to fluids, Performance characteristics, fan laws, selection of centrifugal, axial, mixed flow, Axial flow machines	6
03	**Analysis of centrifugal Machines:** Centrifugal Compressors and Blowers: Theoretical characteristic curves, Eulers characteristics and Euler's velocitytriangles, losses and hydraulic efficiency, flow through inlet nozzle, impeller, diffusers, casing, leakage, disc friction, mechanical losses, cross flow fans	7
04	**Analysis of axial flow Machines:** Axial flow fans and compressors: Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist, stage design, surge, choking and stall, stator and casing, mixed flow impellers. Design considerations for supersonic flow	7
05	**Design and applications of blowers and Fans:** Special design and applications of blower induced and forced draft fans for air-conditioning plants, cooling towers, ventilation systems, booster systems.	7
06	**Testing and control of Blowers and Fans:** Performance testing, noise control,speed control, throttling control at discharge and inlet.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimumTwo Modules)** and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module willbe proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References:

1. Stepanoff A.J. **Turboblowers**, John Wiley & sons, 1970.
2. Brunoeck, **Fans**, Pergamon Press, 1973.
3. Austin H. Chruch, **Centrifugal pumps and blowers**, John wiley and Sons, 1980.
4. Dixon, **Fluid Mechanics, Thermodynamics of turbomachinery**, Pergamon Press, 1984.
5. Dixo,**Worked examples in turbomachinery**, Pergamon Press, 1984.
6. Budugur Lakshminarayana, **Fluid Dynamics and heat Transfer of Turbomachinery**, JohnWiley and Sons, Inc
7. **Handbook of Turbomachinery**, Edited by Earl Logan Jr, Ramendra Roy; Second Edition ,Marcel Dekker, Inc, New York
8. Rama S.R.Gorla, Aijaz Khan, **Turbomachinery Design and Theory**, Marcel Dekker, Inc, NewYork

Course Code	Course Name	Credits
TEPE1022	**Energy Audit and Management**	**3**
	Objectives: 1. To understand the importance energy security for sustainable development and the fundamentals ofenergy conservation. 2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management 3. To relate the data collected during performance evaluation of systems for identification of energysaving opportunities. Outcomes: Learner will be able to… 1. To identify and describe present state of energy security and its importance. 2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility. 3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. 4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities 5. To analyze the data collected during performance evaluation and recommend energy saving measures	
Module	**Detailed Contents**	**Hrs.**
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	**6**
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	7

03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipment's and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	7
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	7
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	6
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	6

Assessment:

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   (b) will be from any module other than module 3)

4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy ResearchInstitute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
TEPE1023	**Advanced Fluid Mechanics**	**3**
	Objectives: 1. To study application of mass, momentum and energy equations in fluid flow. 2. To study different types of turbulent model 3. To study incompressible and compressible fluid flow 4. To familiarize with dimensional analysis of Thermal and Fluid systems. **Outcomes:** Upon successful completion of this course, the learner will be able to 1. Formulate and solve equations of the control volume for fluid flow systems 2. Calculate resistance to flow of incompressible fluids through closed conduits and over surfaces. 3. Select suitable turbulent model for fluid flow problem	
Module	**Detailed Contents**	**Hrs.**
1.	Eulerian & Lagrangian coordinates, Definition and equations for source, sink, irrotational vortex, circulation concept of circulation. Navier-Stokes equations-differential & integral approach, energy equations, governing equations for Newtonian fluids, boundary conditions Momentum of fluid in motion: impulse momentum relationship and its applications for determination of thrust for pipe bend	7
2.	Viscous Incompressible Flows: Exact solutions for Couette flow, Poiseuille flow, flow between rotating cylinders, Stokes first problem, Stokes second problem, pulsating flow between parallel surfaces, stagnation-point flow, flow over porous wall. Stokes approximation,	6
3.	Introduction to dimensional analysis of thermal and fluid systems, Methods of dimensional analysis - Buckingham π Theorem and Rayleigh's Method (Only derivations, no numerical) Boundary Layer Theory: Review of boundary layers: laminar and turbulent boundary layers; transition; separation, Blasius' solution for boundary layer	6
4.	Potential Flows: Stokes stream functions, solution of potential equation, flow in a sector, flow around a sharp edge, flow near a blunt nose force and moment on a circular cylinder and sphere, conformal transformations, Joukowski transformations, Elements of airfoil and wing theory.	6
5.	Introduction to turbulence: Transition of flows, Origin of turbulence- its consequences; Physics of turbulent motion- concept of Reynolds stress, mean flow equations, Turbulence models RANS, LES. DNS	6
6.	Compressible Fluid flow: Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Stagnation properties, Application of continuity, momentum and energy equations for steady-state conditions; Steady flow through the nozzle, Isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio.. Application to subsonic, transonic and supersonic flow around a two-dimensional aerofoil.	7

Text/Reference Books: -

1. Advanced Fluid Mechanics, K. Muralidhar& G. Biswas, Narosa Publishing, 2005.
2. Boundary Layer Theory, H. Schlichting, 6th Edition, McGraw-Hill Inc., 1986.
3. Turbulent Flow, R. J. Garde, 2nd Edition, New Age International Publishers.
4. Foundations of Fluid Mechanics, S.W. Yuan, Prentice-Hall India Pvt. Ltd, New Delhi.
5. Modern Compressible Flow with Historical Perspective, John D. Anderson, McGraw Hill.
6. Fundamentals of Aerodynamics (2nd ed), J. D. Anderson, McGraw Hill.
7. Viscous Fluid Flow, F. M. White, 2nd Edition, McGraw-Hill, 1991.
8. Fundamentals of Fluid Mechanics , B.R. Munson, D.F. Young & T.H. Okiishi, 2nd Ed., John Wiley.
9. Introduction to Fluid Mechanics, R.W. Fox & A.T. McDonald, 5th Edition, John Wiley, 2001.

Course Code	Course Name	Credits
TEIE1011	**Product Life Cycle Management**	**3**
	Objectives: 1. To familiarize the students with the need, benefits and components of PLM 2. To acquaint students with Product Data Management & PLM strategies 3. To give insights into new product development program and guidelines for designing and developing a product 4. To familiarize the students with Virtual Product Development **Outcomes:** Learner will be able to… 1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. 2. Illustrate various approaches and techniques for designing and developing products. 3. Apply product engineering guidelines / thumb rules in designing products for moldings, machining, sheet metal working etc. **4.** Acquire knowledge in applying virtual product development tools for components,machining and manufacturing plant	
Module	**Detailed Contents**	**Hrs.**
1	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	**7**

2	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	7
3	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	6
4	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	6
5	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	7
6	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either aclass test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part
   (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation",Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycleapproach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech,ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking",Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
TEIE1012	**Reliability Engineering**	**3**
	Objectives: 1. To familiarize the students with various aspects of probability theory 2. To acquaint the students with reliability and its concepts 3. To introduce the students to methods of estimating the system reliability of simple and complexsystems 4. To understand the various aspects of Maintainability, Availability and FMEA procedure **Outcomes:** Learner will be able to… 1. Understand and apply the concept of Probability to engineering problems 2. Apply various reliability concepts to calculate different reliability parameters 3. Estimate the system reliability of simple and complex systems **4.** Carry out a Failure Mode Effect and Criticality Analysis	
Module	**Detailed Contents**	**Hrs.**
1	**Probability theory:** Probability: Standard definitions and concepts; ConditionalProbability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, StandardDeviation, Variance, Skewness and Kurtosis.	**6**
2	**Reliability Concepts:** Reliability definitions, Importance of Reliability, QualityAssurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time ToFailure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	7
3	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k outof n structure, Complex systems.	7

4	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unitredundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, SuccessPath method, Decomposition method.	6
5	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	7
6	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	6

Assessment:

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End Semester Theory Examination:

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4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
TEIE1013	**Management Information System**	**3**
	Objectives: 1. The course is blend of Management and Technical field. 2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built 3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage 4. Identify the basic steps in systems development **Outcomes: Learner will be able to…** 1. Explain how information systems Transform Business 2. Identify the impact information systems have on an organization 3. Describe IT infrastructure and its components and its current trends 4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making **5.** Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses	
Module	**Detailed Contents**	**Hrs.**
1	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, and Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	**6**
2	Data and Knowledge Management: Database Approach, Big Data, Data warehouse andData Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis andPresenting Results	7
3	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	6
4	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
5	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
6	Information System within Organization: Transaction Processing Systems, FunctionalArea Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development lifecycle models.	7

<u>Assessment</u>:

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   (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall,2008

Course Code	Course Name	Credits
TEIE1014	**Design of Experiments**	**3**
	Objectives: 1. To understand the issues and principles of Design of Experiments (DOE) 2. To list the guidelines for designing experiments 3. To become familiar with methodologies that can be used in conjunction with experimental designsfor robustness and optimization **Outcomes:** Learner will be able to… 1.Plan data collection, to turn data into information and to make decisions that lead to appropriateaction 2.Apply the methods taught to real life situations 3.Plan, analyze, and interpret the results of experiments	

Module	Detailed Contents	Hrs.
1	**Introduction** Strategy of Experimentation, Typical Applications of Experimental Design , Guidelines for Designing Experiments , Response Surface Methodology	**6**
2	**Fitting Regression Models** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression , Confidence Intervals in Multiple Regression, Prediction of new response observation Regression model diagnostics, Testing for lack of fit	7
3	**Two-Level Factorial Designs and Analysis** he 2^2 Design , The 2^3 Design , The General2^k Design , A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design , Split-Plot Designs	7
4	**Two-Level Fractional Factorial Designs and Analysis** The One-Half Fraction of the 2^k Design , The One-Quarter Fraction of the 2^k Design , The General 2^{k-p} Fractional Factorial Design , Resolution III Designs , Resolution IV and V Designs , Fractional Factorial Split-Plot Designs	7

5	**Conducting Tests** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets , Example experiments , Attribute Vs Variable data sets	6
6	**Taguchi Approach** Crossed Array Designs and Signal-to-Noise Ratios , Analysis Methods Robust design examples	6

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4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley& Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York,2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovationand Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc.ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D.T.Voss

Course Code	Course Name	Credits
TEIE1015	**Operations Research**	**3**
	Objectives: 1. Formulate a real-world problem as a mathematical programming model. 2. Understand the mathematical tools that are needed to solve optimization problems. 3. Use mathematical software to solve the proposed models. **Outcomes:** Learner will be able to… 1. Understand the theoretical workings of the simplex method, the relationship between a linearprogram and its dual, including strong duality and complementary slackness. 2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimalsolution as the data change. 3. Solve specialized linear programming problems like the transportation and assignment problems,solve network models like the shortest path, minimum spanning tree, and maximum flow problems. **4.** Understand the applications of integer programming and a queuing model and compute importantperformance measures	
Module	**Detailed Contents**	**Hrs.**
1	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem.Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel'sapproximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem,Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and mMachines, Graphical Method of Two Jobs m Machines Problem Routing Problem,Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer ProgrammingProblems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	**7**

2	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinitepopulation	6
3	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	7
4	**Dynamic programming**. Characteristics of dynamic programming. Dynamicprogramming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	7
5	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	7
6	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	6

Assessment:

Internal:

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4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", JohnWilley and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
TEIE1016	**Disaster Management and Mitigation Measures**	**3**
	Objectives: 1. To understand physics and various types of disaster occurring around the world 2. To identify extent and damaging capacity of a disaster 3. To study and understand the means of losses and methods to overcome /minimize it. 4. To understand role of individual and various organization during and after disaster 5. To understand application of GIS in the field of disaster management **6.** To understand the emergency government response structures before, during and after disaster **Outcomes: Learner will be able to…** 1. Get to know natural as well as manmade disaster and their extent and possible effects on theeconomy. 2. Plan of national importance structures based upon the previous history. 3. Get acquainted with government policies, acts and various organizational structure associatedwith an emergency. **4.** Get to know the simple do's and don'ts in such extreme events and act accordingly.	
Module	**Detailed Contents**	**Hrs.**
1	**Introduction :-** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long termeffects of disasters. Introduction to global warming and climate change.	**6**
2	**Natural Disaster and Manmade disasters: -** Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea levelrise, ozone depletion Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role ofgrowing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	7
3	**Disaster Management, Policy and Administration** saster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and howto proceed in due course of time, study of flowchart showing the entire process.	6

4	**Institutional Framework for Disaster Management in India:** portance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. e of Internet and software's for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	7
5	**Financing Relief Measures:** ays to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	6
6	**Preventive and Mitigation Measures:** Pre-disaster, during disaster and post-disaster measures in some events in general Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	7

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either aclass test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, publishedby Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth HeinemannElsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by RajdeepDasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, RawatPublications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated informationavailable on authentic web sites)

Course Code	Course Name	Credits
TEIE1017	**Research Methodology**	**3**
	Objectives: 1. To understand Research and Research Process 2. To acquaint students with identifying problems for research and develop research strategies 3. To familiarize students with the techniques of data collection, analysis of data and interpretation Outcomes: Learner will be able to… 1. Prepare a preliminary research design for projects in their subject matter areas 2. Accurately collect, analyze and report data 3. Present complex data or situations clearly 4. Review and analyze research findings	
Module	**Detailed Contents**	**Hrs.**
1	**Introduction and Basic Research Concepts** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis,Hypothesis, Law, Principle. Research methods vs Methodology Need of Research in Business and Social Sciences Objectives of Research **Issues** and Problems in Research Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	**09**
2	**Types of Research** Basic Research Applied Research Descriptive Research Analytical Research Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
3	**Research Design and Sample Design** Research Design – Meaning, Types and Significance Sample Design – Meaning and Significance Essentials of a good sampling Stages inSample Design Sampling methods/techniques Sampling Errors	**07**

4	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f.** Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
5	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis ofdata, Generalization and Interpretation of analysis	**04**
6	**Outcome of Research** Preparation of the report on conclusion reached Validity Testing & Ethical Issues Suggestions and Recommendation	**04**

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimumTwo Modules)** and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module willbe proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four questions need to be solved.

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley EasternLimited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded),Singapore, Pearson Education

Course Code	Course Name	Credits
TEL101	**Renewable Energy Lab**	**1**
	The laboratory will focus on the following, 1.Measurement of solar radiation and sunshine hours, 2.Measurement of albedo, UV & IR radiation, 3. Measurement of emissivity, reflectivity, transmittivity, 4. Performance testing of solar flat plate water heater (forced flow & thermosyphon systems) 5. Performance testing solar air heater & dryer & desalination unit, 6. Performance testing of solar thermal concentrators, 7. Characteristics of photovoltaic devices & testing of solar PV operated pump, 8.Energy consumption & lumen measurement of lights & ballasts. 9. Properties of fuel oils & biomass, 10.Testing of Gasifier or Wind machines or Fuel cell **Assessment:** End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners.	

Course Code	Course Name	Credits
TESBL101	**Simulation of Thermal Systems**	**2**
	Simulation study using mathematical simulation software (or any programming language) onany six Performance test on Spark Ignition engines using Alternate fuels such as ethanol and LPG. 1. Simulation studies of Vapor Absorption System. 2. Simulation studies of Petrol and Diesel engine cycles. 3. Simulation of Gas Turbine Cycles. 4. Simulation of Adiabatic flame temperature in constant volume heat addition process. 5. Simulation of Adiabatic flame temperature in constant pressure heat addition process 6. Calibration of a cryogenic temperature-measuring instrument. 7. Trial / Design of Sterling cycle refrigerator. 8. Trial / Design of Pulse tube refrigerator. **Assessment:** **End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners	

Course Code	Course Name	Credits
TEC201	**Refrigeration and Air Conditioning System Design**	**3**
	Objectives 1. To understand industrial refrigeration and air conditioning systems and their analysis 2. Impart knowledge of psychrometry and its application in air conditioning system design 3. Know how about controls in refrigeration and air conditioning **Outcomes:** Learner will be able to… 1. Analyse performance of various refrigeration cycles and air conditioning systems 2. Identify suitable refrigeration system and propose design of the same **3.** Design conventional or non-conventional air conditioning system for specific application	

Module	**Detailed Contents**	**Hrs.**
1	REFRRIGERATION CYCLES: Analysis, Multi-pressure Systems, REFRIGERANTS: Classification of Refrigerants, Refrigerant Properties, Oil Compatibility, Blends, System Design Criteria for New Refrigerants, Phase-out Schedule, Natural Refrigerants**,**	**6**
2	SYSTEM COMPONENTS: Refrigeration Compressors, Different Types, Performance, Capacity Control, Evaporators, Evaporator Circuitry, Applications and Different Types, Condensers, Types, Evaporative Condensers, Optimum Cooling Water Rate and Velocity, Cooling Towers, Range and Approach, Refrigerant piping, pressure drops , optimum pipe sizing	**6**
3	VAPOUR ABSORPTION SYSTEMS: LiBr & Aqua Ammonia Systems. Double Effect Chillers. Solar Energy operated m/c's INDUSTRIAL REFRIGERATION: Cold Stores, Ammonia Refrigeration Systems, Safety requirement for refrigeration systems. Introduction to Refrigeration systems for various applications such as petrochemical, food, pharmaceutical, etc.	**7**
4	PSYCHROMETRICS: Introduction, Properties of air and water vapour mixture. Psychrometric chart and its use in air conditioning. ASHRAE Comfort Chart DESIGN OF EQUIPMENTS: Analysis of air conditioning load, load calculation. Equipment selection and balancing	**7**
5	AIR CONDITIONING SYSTEMS: Window Type, Package Type, Split Type, Central Units – direct and indirect. Construction details. Evaporative cooling system. AIR DISTRIBUTION: Air Distribution Devices – Air Circuits – Design of Air Supply System. Noise consideration	**7**

6	CONTROLS: Electrical components & controls, starting and running circuits, relay types and controls, Temperature, Pressure, Oil Flow controls, Compressor Motor- Protection Devices, Refrigeration valves NON-CONVENTIONAL HVAC SYSTEMS: Multi Stage Evaporative Cooling, Simultaneous Cooling and Heating, Adsorption Chillers, Radiant Cooling Systems, Geothermal Systems, Magnetic Refrigeration.	**6**

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course projector Visit to Refrigeration Plant.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module willbe proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four questions need to be solved.

References:

1. Dossat, R.J., **Principles of Refrigeration**, John Wiley & Sons, 1989.
2. Stoecker W.F., **Refrigeration and Air Conditoning**, McGraw Hill Book Company, 1985.
3. Jordan and Priester, **Refrigeration and Air Conditioning**, 1985.
4. Althouse, A.D. and Turnquist, C.H., **Modern Refrigeration and Air Conditioning**, GoodHeart – Wilcox Co.
5. Hains, J.B., **Automatic Control of Heating and Air Conditioning**, McGraw Hill, 1981.
6. **ASHRAE Handbooks** (Fundamentals, Equipments and Systems)
7. Ananthanarayanan P N, **Modern Refrigeration and Air Conditioning**, McGraw Hill.
8. Shan K Wang, **Handbook of Refrigeration & Air Conditioning**
9. Threlkeld J L, **Thermal Environmental Engineering**, Prentice-Hall, 1962
10. Gosney W B, **Principles of Refrigeration**,Cambridge University Press, 1982
11. Stoecker W. F., **Industrial refrigeration**, Business News Publishing Company

Course Code	Course Name	Credits
TEC202	**Computational Fluid Dynamics**	**3**
	Objectives 1. Understand the laws of fluid flow for ideal and viscous fluids. 2. Develop finite difference and finite volume discredited forms of the CFD equations. 3. Formulate explicit & implicit algorithms for solving the Euler Equation &Navier StokesEquation. **Outcomes:** Learner will be able to… 1. Explain the fundamental principles of fluid motion and their application to the analysis andsolution of problem in fluid flow engineering. **2.** Solve Fluid dynamic& Heat transfer problem using computational fluid dynamics.	
Module	**Detailed Contents**	**Hrs.**
1	Basics of Fluid Dynamics, Definition and overview of CFD, Advantages and applications, CFD methodology	05
2	GOVERNING DIFFERENTIAL EQUATIONs: Governing equations for mass, momentum and energy; Navier-Stokes equations; Mathematical behavior of PDE's viz. parabolic, elliptic and hyperbolic, Initial and boundary conditions, Initial and Boundary value problems. Selection criteria for BC	08
3	DISCRETIZATION TECHNIQUES: Introduction to Finite difference Method, Finite Volume method and Finite Element method Finite difference methods; Finite difference representation of PDE's; Solutions to Finite Difference Equations; Implicit, semi-implicit and explicit methods; Errors and stability criteria	08
4	FINITE VOLUME METHODS: FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady; Advection schemes; Pressure velocity coupling; SIMPLE family of algorithms	08
5	GRID GENERATION : Structured and Unstructured Grids; General transformations of the equations; body fitted coordinate systems; Algebraic and Elliptic Methods;multi block structured grids; adaptive grids	05
6	TURBULENCE MODELING: Effect of turbulence on governing equations; RANS,LES and DNS Models	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimumTwo Modules)** and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

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4. Only Four questions need to be solved.

References:

1. S.W. Yuan, **Foundations of Fluid Mechanics**, Prentice-Hall India Pvt. Ltd, New Delhi.
2. K. Muralidhar and G. Biswas, **Advanced Fluid Mechanics**, Narosa Publishing, 2005.
3. R.W. Fox and A.T. McDonald, **Introduction to Fluid Mechanics**, 5th Edition, John Wiley,2001.
4. D. A Anderson, I.I. Tannehill , and R.H. Pletcher , **Computational fluid Mechanics andHeat Transfer**, Hemisphere Publishing Corporation, New York , USA, 1984.
5. Muralidhar, K., Sundararajan, T., **Computational fluid flow and heat transfer**, NarosaPublishing House, New Delhi1995
6. Ghosdhasdidar, P.S., **Computer simulation of flow and heat transfer**, Tata Mc Graw-HillPublishing company Ltd., 1998.
7. Anil W Date, **Introduction to Computational Fluid Dynamics**, Cambridge UniversityPress, 2009
8. Fletcher, C.A.J., **Computational Techniques for Fluid Dynamics 1, Fundamental andGeneral Techniques**, Springer- Verlag , 1987
9. H. Schlichting, **Boundary Layer Theory**, 6th Edition, McGraw-Hill Inc., 1986.
10. R. J. Garde, **Turbulent Flow**, 2nd Ed., New Age International Publishers.
11. John D. Anderson, **Modern Compressible Flow with Historical Perspective**, McGrawHill.
12. J. D. Anderson, **Fundamentals of Aerodynamics,** 2nd Ed, McGraw Hill.
13. B.R. Munson, D.F. Young and T.H. Okiishi, **Fundamentals of Fluid Mechanics**, 2nd Ed.,John Wiley.
14. Subas, V.Patankar, **Numerical heat transfer fluid flow** , Hemisphere publishingCorporation.
15. Taylor, C and Hughes J.B., **Finite Element Programming of the Navier Stokes Equation**,Pineridge Press Ltd., U.K , 1981.

Course Code	Course Name	Credits
TEPE2011	**Cryogenics**	**3**
	Objectives 1. Impart basic knowledge of low temperature generation, difficulties in maintaining lowtemperature and solutions 2. Understand applications of cryogenic refrigeration **3.** Understand storage of cryogenic liquids and equipment's, instruments used **Outcomes:** Learner will be able to… 1. Understand use of cryogenic systems, real-time difficulties in storing cryogenic liquids **2.** Identify effects of various components on cryogenic system performance	
Module	**Detailed Contents**	**Hrs.**
1	**Introduction to Cryogenic systems**:- Present areas involving Cryogenic Engineering, Low temperature properties of materials-Mechanical properties, Thermal properties, Electrical and Magnetic Properties, Properties of Cryogenic Fluids, Properties of solids at cryogenic Temperatures; Superconductivity.	08
2	**Liquefaction Systems**–system performance parameters, thermodynamically ideal liquefaction system, Production of Low temperatures- Joule Thomson effect, adiabatic expansion, Liquefaction systems for gasses other than neon, Hydrogen and Helium - Recuperative – Simple Linde – Hampson, precooled linde – Hampson, Linde dual pressure, Claude, Cascade, Heylandt, Kapitza, Liquefaction systems for gases neon, Hydrogen and Helium - Recuperati ve -Collins, Simon; Regenerative – Sterling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas	10
3	**Cryogenic Refrigeration Systems:** Ideal Refrigeration systems, Refrigerators for temperatures above 2k- Joule –Thomson Refrigeration systems, Philips refrigerator, Solvay refrigerator, Vuilleumier refrigerator, Gifford-Mac Mohan Refrigerator, Regenerator Refrigerators for temperatures below 2k- Magnetic cooling, Magnetic refrigeration, Magneto-caloric refrigerator, ^{3}He-^{4}He Dilution refrigerators, thermal valves.	10

4	**Instrumentation, measurement systems &cryogenic Insulations-** Temperature, Pressure, Flow rate, Fluid quality, Liquid level measurement systems. C**ryogenic Insulations** Expanded foams, Vacuum insulation, Evacuated powders and fibrous materials insulation, Gas filled powders and fibrous materials, opacified powder, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.	08
5	**Storage of cryogenic liquids:** Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenicliquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system ,Cool- down of storage and transfer systems	08
6	**Cryogenic equipment's & Cryogenic Applications-** Cryogenic heat exchangers – recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders ,Turbo alternators; Effect of component inefficiencies on system performance, systemoptimization, cryocoolers **Cryogenic Applications-** Cryogenic Engineering applications in energy, aeronautics, space industry, biology& medicine,food preservation, Transport, Cryo pumping;	08

<u>Assessment</u>:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimumTwo Modules)** and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

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4. Only Four questions need to be solved.

References:

1. Klaus D. Timmerhause and Thomas M Flynn, **Cryogenic Process Engineering**, PlenumPress, New York, 1989
2. Randall F Barron, **Cryogenic Systems**, McGraw Hill, 1985
3. A Bose and P Sengupta, Cryogenics: **Applications and Pregress**, TMH
4. Scott R B, **Cryogenic Engineering**, Van Nostrand and Co., 1962
5. Herald Weinstock, **Cryogenic Technology**, 1969
6. A. Bose and P. Sengupta, **Cryogenics: Applications and Progress**, Tata McGraw Hill.
7. T.M. Flynn, **Cryogenic Engineering**, Marcel Dekker
8. K D Timmerhaus ansd T M Flynn, **Cryogenic Precess Engineering**, Plenun Press
9. J.G. Weisend II (Editor), **Handbook of Cryogenic Engineering**, Taylor and Francis
10. G.G. Haselden, **Cryogenic Fundamentals**, Academic Press.
11. C.A. Bailey(Editor), **Advanced Cryogenics**, Plenum Press.
12. R.W. Vance and W.M. Duke (Editors), **Applied Cryogenic Engineering**, John Wiley&sons.

Course Code	Course Name	Credits
TEPE2012	**Internal Combustion Engine Design**	**3**
	Objectives: - 1. Understand design considerations in IC Engine 2. Learn optimization of engine components and prepare working drawings 3. Learn design aspects of engine accessories and mountings **Outcomes:** Learner will be able to… 1. Design complete engine with all its components, mountings and accessories **2.** Quantify the effect of change in fuel on engine design and its performance	
Module	**Detailed Contents**	**Hrs.**
1	General Considerations in Engine Design: Principle of similitude, choice of cycle, speed, fuel, bore and stroke, cylinder arrangement, choice of material, stress and fatigue considerations, design for manufacture	8
2	Design of Major Components: Piston system, connecting rod assembly, crankshaftsystem, valve gearing ,stress analysis	8
3	Design of Other Components: Inlet and exhaust manifolds, cylinder block, cylinder liner, cylinder head, gaskets, crankcase, Engine foundations and mountings, bearings, flywheel. Turbocharger, supercharger, computer controlled fuel injection system	10
4	Design of Two-Stroke Engines: Arrangement and sizing of ports, piston assembly, intake and exhaust system, scavenging, application to automotive gasoline andmarine diesel engines	10
5	Optimization of Engine Components, Preparation of working drawings of designedcomponents	10
6	Multi-fuel engines, Effect of change in fuel on engine design and performance	6

Assessment:

Internal:

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End Semester Theory Examination:

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References:

1. Maleev V L, **Internal Combustion Engines: Theory and Design**, 2nd Intl. Ed., McGraw-Hill,New York, 1973
2. Gordon P.Blair, **Basic design of Two-stroke Engines**, S.A.E., 1992.
3. Gordon P.Blair, **Advanced Concepts of Two-stroke Engines**, S.A.E., 1990.
4. Pounder, C.C., **Marine Diesel Engines**, Butterworths, 1981.
5. A.Kolchin and V.Demidov, **Design of Automotive Engines**, Mir Publishers, Moscow, 1984.
6. Gordon P.Blair, **Design and Simulation of Four-Stroke Engines**, S.A.E., Inc.,USA, 1999.
7. D.E. Winterbone and R.J.Pearson, **Design Techniques for Engine Manifolds, Wave actionmethods for I.C Engines**, Professinal Engineering Publishing Ltd., UK, 2000

Course Code	Course Name	Credits
TEPE2013	**Modeling and Analysis in Thermal Engineering**	**3**
Module	**Detailed Contents**	**Hrs.**
1	Introduction, Design versus analysis, need for optimization, basic characteristics ofthermal systems, analysis, types and examples: energy systems, cooling systems for electronic equipment, environmental and safety systems, air-conditioning,refrigeration and heating systems, heat transfer equipment	**7**
2	Modeling of thermal systems, basic considerations in design, importance ofmodeling in design, types of models, mathematical modeling, physical modeling and dimensional analysis	**7**
3	Numerical modeling and simulation, development of a numerical model, solution procedure, merging of different models, accuracy and validation, system simulation, methods of numerical simulation, numerical simulation versus real systems	**7**
4	Economic considerations, calculation of interest, worth of money as a function oftime, raising capital, economic factors in design, application to thermal systems	**6**
5	Problem formulation for optimization, basic concepts, optimization methods, optimization of thermal systems, practical aspects in optimal design	**6**
6	Knowledge based design and additional considerations, knowledge based systems,additional constraints, sources of information	**6**

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimumTwo Modules)** and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.
5.

References:

2. Yogesh Jaluria, **Design and Optimization of Thermal Systems**, McGraw-Hill internationaleditions, 1998
3. Stoecker W F,**Design of Thermal Systems**, 3rd Ed. McGraw Hill, 2011
4. Eckert E R G and Drake R M,**Analysis of Heat and Mass Transfer**, McGraw-Hill, New York,1972
5. Szucs E,**Similitude and Modeling**, Elsevier, New York, 1977
6. Wellstead P E,**Introduction to Physical System Modeling**, Academic Press, New York, 1979
7. Chapra S C and Canale R P,**Numerical Methods for Engineers**, McGraw-Hill, New York,1988
8. Atkinson K,**An Introduction to Numerical Analysis**, Wiley, New York, 1978

Course Code	Course Name	Credits
TEPE2021	**Non-Conventional Power Plants**	**3**
	Objectives 1. Understand need, usefulness and feasibility of non-conventional power plants in global as well as Indian context 2. Learn environmental and socioeconomic impacts of such power plants Outcomes: Learner will be able to… 1. Understand power crunch and propose green solution to overcome it 2. Evaluate potential opportunities in non-conventional power sector	
01	Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy.	06
02	Solar thermal power plants (Concentrators, solar chimney etc.), Solar thermal conversiosn devices, Economics and social considerations, Design considerations of component selection. Solar photovoltaic power plants, photovoltaic technology, Design of a photovoltaic system, economics and costing, Application as a distributed power supply strategy	07
03	Wind energy: Wind energy potential measurement, wind electric generator component design, economics and demand side management, energy wheeling, and energy banking concepts.	06
04	Biogas: properties of biogas (Calorific value and composition), biogas plant technology and status	06
05	Other plants: Fuel cell based power plants, tidal and wave energy plant design, OTEC power plants. Geothermal energy: hot springs and steam ejection site selection, power plants, and economics.	07
06	Environmental impacts, Economic and social considerations, Financing mechanisms, Carbon credits, clean development mechanisms	06

Course Code	Course Name	Credits
TEPE2022	**Steam and Gas Turbines**	**3**
	Objectives 1. To understand classification, construction, operation and maintenance of steam turbines 2. To learn gas turbine operation cycles and its performance 3. Understand auxiliary systems in steam as well as gas turbines Outcomes: Learner will be able to… 1. Estimate and quantify performance of stema as well as gas turbine 2. Solve numerical on steam and gas turbine sizing	
Module	**Detailed Contents**	**Hrs.**
01	Classification of steam turbines, combination of turbines, overview of turbines, Flow of steam through impulse turbine blades / impulse and reaction turbines blades, Energy losses in steam turbines, governing and performance of steam turbines	06
02	Steam turbine auxiliary systems: turbine protective devices, tripping devices, unloading gears, lubricating systems, glands and sealing systems	07
03	Construction, Operation and Maintenance of Steam Turbines	07
04	Gas Turbine-shaft power cycles, velocity diagram and work done by gas turbine, turbine blade cooling, blade materials, blade manufacture, matching of turbine components,	06
05	Combustion chambers, requirements, types, factor affecting performance of CC, performance of turbines	06

Course Code	Course Name	Credits
TEPE2023	**Heat Exchanger Design and Performance**	**3**
	Objectives 1. Impart knowledge of sizing and designing of various heat exchangers using various methods 2. Learn performance analysis and maintenance aspects of heat exchaning equipments **Outcomes:** Learner will be able to… 1. Customize sizing and/or designing of heat exchangers **2.** Identify efficasy of conventional or compact heat exchangers for specific purpose	
Module	**Detailed Contents**	**Hrs.**
1	Constructional Details and Heat Transfer: Types - Shell and Tube Heat Exchangers - Regenerators and Recuperators - Industrial Applications, Methodology,Design consideration, Temperature Distribution and its Implications - LMTD – Effectiveness	07
2	Flow Distribution and Stress Analysis: Effect of Turbulence –Effect of Fouling-Friction Factor - Pressure Loss - Channel Divergence Stresses in Tubes - Heatersheets and Pressure Vessels - Thermal Stresses - Shear Stresses - Types of Failures	06
3	Design Aspects: TEMA standard, Heat Transfer and Pressure Loss - Flow Configuration - Effect of Baffles - Effect of Deviations from Ideality - Design of Typical Liquid - Gas-Gas-Liquid Heat Exchangers, Surface heat transfer and enhancement	08
4	Condensers and Evaporators Design: Design of Surface and Evaporative Condensers - Design of Shell and Tube - Plate Type Evaporators	06
5	Cooling Towers: Types- Spray Design - Selection of Fans- Testing and Maintenance of cooling towers,Compact cooling towers, cooling towerperformance variable	06
6	Design of Special Purpose Heat Exchangers: corrosive environment. Marine/spaceapplications, compact heat exchanger	06

Assessment:

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End Semester Theory Examination:

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4. Only Four questions need to be solved

References:

1. Shah R K, Sekulic D P, **Fundamentals of Heat Exchanger Design**, John Wiley, 2003
2. Kakac Sadik, Liu Hongtan, **Heat exchangers : selection, rating and thermal design**, 2nd ed,CRC Press, 2002
3. D Q Kern, **Precess Heat Transfer,** McGraw Hill
4. W. M. Kays and A. L. London,**Compact heat exchanger**, 3 Sub Edition, Krieger Pub Co
5. Mojtaba Sabet,**Cooling tower fundamentals and best design practices,** Outskirts Press,2014
6. T. Taborek, G.F. Hewitt and N.Afgan, **Heat Exchangers, Theory and Practice**, McGrawHill Book Co., 1980
7. Walker, **Industrial Heat Exchangers - A Basic Guide**, McGraw Hill Book Co., 1980
8. Nicholas Cheremisioff, **Cooling Tower**, Ann Arbor Science Pub 1981
9. Arthur P. Fraas, **Heat Exchanger Design**, John Wiley & Sons, 1988

Course Code	Course Name	Credits
TEIE2011	**Project Management**	**3**
	Objectives: 1. To familiarize the students with the use of a structured methodology/approach for each and everyunique project undertaken, including utilizing project management concepts, tools and techniques. **2.** To appraise the students with the project management life cycle and make them knowledgeableabout the various phases from project initiation through closure. **Outcomes:** Learner will be able to… 1. Apply selection criteria and select an appropriate project from different options. 2. Write work break down structure for a project and develop a schedule based on it. 3. Identify opportunities and threats to the project and decide an approach to deal with themstrategically. 4. Use Earned value technique and determine & predict status of the project. **5.** Capture lessons learned during project phases and document them for future reference	
Module	**Detailed Contents**	**Hrs.**
1	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
2	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
3	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8

4	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, ProjectStakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and riskregister. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
5	**Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engagingwith all stakeholders of the projects. Team management, communication and project meetings. **Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Usingmilestones for measurement; change requests and scope creep. Project audit. **Project Contracting :-**Project procurement management, contracting and outsourcing,	8
6	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects.Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

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4. Only Four questions need to be solved.

References:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, ProjectManagement Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
TEIE2012	**Finance Management**	**3**
	Objectives: 1. Overview of Indian financial system, instruments and market 2. Basic concepts of value of money, returns and risks, corporate finance, working capital and itsmanagement 3. Knowledge about sources of finance, capital structure, dividend policy **Outcomes:** Learner will be able to… 1. Understand Indian finance system and corporate finance **2.** Take investment, finance as well as dividend decisions	
Module	**Detailed Contents**	**Hrs.**
1	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of FinancialInstitutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
2	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06

3	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions ofCorporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profitand Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis;Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital StructureRatios; Stock Market Ratios; Limitations of Ratio Analysis.	09
4	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for CapitalBudgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return,Payback Period, Discounted Payback Period, Net Present Value(NPV), ProfitabilityIndex, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance ofWorking Capital Management; Factors Affecting an Entity's Working Capital Needs;Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
5	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
6	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting anEntity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

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End Semester Theory Examination:

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2. All question carry equal marks
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4. Only Four questions need to be solved.

References:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F.Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGrawHill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, NewDelhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & CompanyLimited, New Delhi.

Course Code	Course Name	Credits
TEIE2013	**Entrepreneurship Development and Management**	**3**
	Objectives: 1. To acquaint with entrepreneurship and management of business 2. Understand Indian environment for entrepreneurship **3.** Idea of EDP, MSME **Outcomes:** Learner will be able to… 1. Understand the concept of business plan and ownerships 2. Interpret key regulations and legal aspects of entrepreneurship in India **3.** Understand government policies for entrepreneurs	
Module	**Detailed Contents**	**Hrs.**
1	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	06
2	**Business Plans and Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	06
3	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	06
4	**Indian Environment for Entrepreneurship:** key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	07

5	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	07
6	**Achieving Success in The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small businessCritical Success factors of small business	06

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4. Only Four questions need to be solved.

References:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition,The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications,New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
TEIE2014	**Human Resource Management**	**3**
	Objectives: 1. To introduce the students with basic concepts, techniques and practices of the human resource management. 2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations. 3. To familiarize the students about the latest developments, trends & different aspects of HRM. 4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers. **Outcomes:** Learner will be able to… 1. Understand the concepts, aspects, techniques and practices of the human resource management. 2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective. 3. Gain knowledge about the latest developments and trends in HRM. **4.** Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.	
Module	**Detailed Contents**	**Hrs.**
1	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies ofHR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	**5**

2	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for BehavioralChange (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	**7**
3	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tacticsand strategies.	6
4	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, PerformanceCounseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
5	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as atool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6

6	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	7

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End Semester Theory Examination:

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References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, HimalayaPublishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013,Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
TEIE2015	**Professional Ethics and Corporate Social Responsibilities**	**3**
Module	**Detailed Contents**	**Hrs.**
1	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	06
2	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition;Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	06
3	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
4	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	06
5	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India,Corporate Social Responsibility and Public-Private Partnership (PPP) in India	06
6	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	07

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References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta;Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane,Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher:Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
TEIE2016	**IPR and Patenting**	**3**
	Objectives: 1. To understand intellectual property rights protection system 2. To promote the knowledge of Intellectual Property Laws of India as well as International treatyprocedures **3.** To get acquaintance with Patent search and patent filing procedure and applications **Outcomes:** Learner will be able to… 1. understand Intellectual Property assets 2. assist individuals and organizations in capacity building **3.** work for development, promotion, protection, compliance, and enforcement of Intellectual Propertyand Patenting	
Module	**Detailed Contents**	**Hrs.**
1	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Differentcategory of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
2	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
3	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
4	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07

5	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPSagreement, Paris convention etc.)	08
6	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

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4. Only Four questions need to be solved.

References:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India,The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group onPatent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: CurrentTrends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights,Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. PrabhuddhaGanguli, 2012, Intellectual Property Rights, 1st Edition, TMH

8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, ExcelBooks
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, SerialPublications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BSPublications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual PropertyRights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, WorldScientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi**,** IPR: Drafting,Interpretation of PatentSpecifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
TEIE2017	**Digital Business Management**	**3**
	Objectives: 1. To familiarize with digital business concept 2. To acquaint with E-commerce 3. To give insights into E-business and its strategies **Outcomes:** The learner will be able to ….. 1. Identify drivers of digital business 2. Illustrate various approaches and techniques for E-business and management **3.** Prepare E-business plan	
Module	**Detailed Contents**	**Hrs.**
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, social media, BYOD, and Internet of Things (digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business ECand Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledgeTope Apps, Information and referral system **Application Development:** Building Digital business Applications andInfrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private	06

	Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company'sInternal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

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References:

1. A textbook on E-commerce**,** ErArunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors,2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theoryand practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
TEIE2018	**Environmental Management**	**3**
	Objectives: 1. Understand and identify environmental issues relevant to India and global concerns 2. Learn concepts of ecology **3.** Familiarize environment related legislations **Outcomes:** Learner will be able to… 1. Understand the concept of environmental management 2. Understand ecosystem and interdependence, food chain etc. **3.** Understand and interpret environment related legislations	
Module	**Detailed Contents**	**Hrs.**
1	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	07
2	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man- made disasters, Atomic/Biomedical hazards, etc.	
3	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	
4	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	
5	Total Quality Environmental Management, ISO-14000, EMS certification.	
6	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimumTwo Modules)** and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London,1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, EdwardElgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use,Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India,2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Credits
TEL201	**CFD Lab**	**1**
	The laboratory will focus on the following: 1. Give adequate exposure to commercially available analysis packages 2. Train students to write simple codes in MATLAB, C, C++ for control volume analysis 3. Give students an understanding of the working of a complete code through exercises on simple flows The laboratory assignments should be based on the following: 1. Simulate and solve 2-d and 3-d steady and unsteady flows using any commercial CFD package like Ansys-FLUENT, STAR CCM, FLUIDYNE, Ansys-CFX, etc. 2. Write codes for 1-d and 2-d steady conduction with and without source and do the post processing to verify with analytical results 3. Write codes for steady, 2-d conduction-advection problems and do the post processing to verify with analytical results	
	Assessment: End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners	

Course Code	Course Name	Credits
TESBL201	**Virtual Instrumentation Lab**	**2**
	Topic Study of sensor characteristics, selection, calibration and measurement of minimum 05 mechanical parameters such as flow, load, pressure, speed and temperature Virtual Instrumentation Simulation of any system with Virtual Instrumentation (VI) environment using any suitable software Interfacing of sensors used for measuring above mentioned parameters in I with VI software and measurement of these parameters on any laboratory model or actual working system Demonstration of interfacing of VI software with suitable generic hardware **Assessment:** End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners	