UNIVERSITY OF MUMBAI
No. UG/14/of 2016-17

CIRCULAR:-

A reference is invited to the syllabi relating to the Master of Engineering (Mechanical) Heat Power Engineering degree course **vide** this office Circular No.UG/08 of 2013-14, dated 23rd April, 2013 and the Principals of affiliated Colleges in Engineering are hereby informed that the recommendation made by Ad-hoc Board of Studies in Electrical Engineering at its meeting held on 8th July, 2016 has been accepted by the Academic Council at its meeting held on 14th July, 2016 **vide** item No. 4.31 and that in accordance therewith, the revised syllabus as per Choice Based Credit System for Master of Engineering (Mechanical) Heat Power Engineering (Sem. I & II), which is available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

9/11/16

(Dr.M.A.Khan)
REGISTRAR

MUMBAI – 400 032
9th November, 2016

To,

The Principals of affiliated Colleges in Engineering.

A.C/ 4.31/14/07/2016.

****

No. UG/14-A of 2016 MUMBAI-400 032 9th November, 2016

Copy forwarded with compliments for information to:-

1. The Dean, Faculty of Technology,
2. The Chairmen, Ad-hoc Board of the Studies in Electrical Engineering
3. The Director, Board of College and University Development,
4. The Controller of Examinations,
5. The Co-Ordinator, University Computerization Centre.

9/11/16

(Dr.M.A.Khan)
REGISTRAR

PTO

AC 14.7.2016
Item No. 4.31

UNIVERSITYOFMUMBAI

Revised Syllabus for the M. E. Program

Program: M. E. (Mechanical)

HEAT POWER ENGINEERING

(As per **Choice Based Credit and GradingSystem** with effect from the academic year 2016–2017)

From Co-ordinator's Desk:-

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. 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 Technology, University of Mumbai, in one of its meetings unanimously 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 affiliated institutes understand the depth of approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry are to be involved while revising the curriculum. I am happy to state that, each 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 and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education, since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. 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. Choice Based Credit and Grading System is implemented for Master of Engineering from the academic year 2016-2017.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Mechanical Engineering of University of the Mumbai, I am happy to state here that, the Program Educational Objectives for Postgraduate Program were finalized in a brain storming session, which was attended by more than 20 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Mechanical Engineering. 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 above, 2 to 3 more program educational objectives of their own may be added by affiliated Institutes.

In addition to Program Educational Objectives, for each course of postgraduate program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stake holders.

Dr. S. M. Khot

Chairman, Board of Studies in Mechanical Engineering, University of Mumbai

Program Structure for
ME Mechanical Engineering (Heat Power Engineering)
Mumbai University
(With Effect From 2016-2017)

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
HPEC101	Advanced Heat Transfer#	04	--	04	--	04
HPEC102	Advanced Thermodynamics	04	--	04	--	04
HPEC103	Gas Turbine and Steam Turbine	04	--	04	--	04
HPEDLO 101X	Department Level Optional Course I	04	--	04	--	04
ILO101X	Institute Level Optional Course I	03	--	03	--	03
HPEL101	Laboratory I - Simulation of Thermal Systems	--	02	--	01	01
HPEL102	Laboratory II - Refrigeration and Air conditioning Technologies	--	02	--	01	01
Total		**19**	**04**	**19**	**02**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
HPEC101	Advanced Heat Transfer#	20	20	20	80	03	--	--	100
HPEC102	Advanced Thermodynamics	20	20	20	80	03	--	--	100
HPEC103	Gas Turbine and Steam Turbine	20	20	20	80	03	--	--	100
HPEDLO 101X	Department Level Optional Course I	20	20	20	80	03	--	--	100
ILO101X	Institute Level Optional Course I	20	20	20	80	03	--	--	100
HPEL101	Laboratory I - Simulation of Thermal Systems	--	--	--	--	--	25	25	50
HPEL102	Laboratory II - Refrigeration and Air conditioning Technologies	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**		**50**	**50**	**600**

Course Code	Department Level Optional Course I	Course Code	Institute Level Optional Course I
HPEDLO1011	Utilization of Solar Energy #&	ILO1011	Product Lifecycle Management
HPEDLO1012	Cogeneration and Waste Heat Recovery Systems #&	ILO1012	Reliability Engineering
HPEDLO1013	Alternative Fuels#&	ILO1013	Management Information System
HPEDLO1014	Design of Refrigeration and Air conditioning Systems	ILO1014	Design of Experiments
		ILO1015	Operation Research
		ILO1016	Cyber Security and Laws
		ILO1017	Disaster Management and Mitigation Measures
		ILO1018	Energy Audit and Management

 # Common with Thermal Engineering and Heat Power Engineering
& Common for Thermal Engineering and Energy Systems and Management

Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
HPEC201	Modelling and Analysis in Thermal Engineering #	04	--	04	--	04
HPEC202	Advanced Fluid Mechanics	04	--	04	--	04
HPEC203	Heat Exchanger Design and Performance #	04	--	04	--	04
HPEDLO 202X	Department Level Optional Course II	04	--	04	--	04
ILO202X	Institute Level Optional Course II	03	--	03	--	03
HPEL201	Laboratory III - Computational Fluid Dynamics	--	02	--	01	01
HPEL202	Laboratory IV - Energy Audit	--	02	--	01	01
Total		**19**	**04**	**19**	**02**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End SemExam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
HPEC201	Modelling and Analysis in Thermal Engineering #	20	20	20	80	03	--	--	100
HPEC202	Advanced Fluid Mechanics	20	20	20	80	03	--	--	100
HPEC203	Heat Exchanger Design and Performance #	20	20	20	80	03	--	--	100
HPEDLO 202X	Department Level Optional Course II	20	20	20	80	03	--	--	100
ILO202X	Institute Level Optional Course II	20	20	20	80	03	--	--	100
HPEL201	Laboratory III - Computational Fluid Dynamics	--	--	--	--	--	25	25	50
HPEL202	Laboratory IV - Energy Audit	--	--	--	--	--	25	25	50
Total			**100**	**100**	**400**		**50**	**50**	**600**

**Common with Thermal Engineering and Heat Power Engineering**

& **Common with Thermal Engineering and Energy Systems and Management**

Course Code	Department Level Optional Course II	Course Code	Institute Level Optional Course II
HPEDLO2021	Cryogenics #	ILO2021	Project Management
HPEDLO2022	Computational Fluid Dynamics& Heat Transfer	ILO2022	Finance Management
HPEDLO2023	Advanced Turbo Machinery#	ILO2023	Entrepreneurship Development and Management
HPEDLO2024	Non-Conventional Power Plants #	ILO2024	Human Resource Management
		ILO2025	Professional Ethics and CSR
		ILO2026	Research Methodology
		ILO2027	IPR and Patenting
		ILO2028	Digital Business Management
		ILO2029	Environmental Management

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
HPES301	Seminar	--	03	--	03	03
HPED301	Dissertation I	--	24	--	12	12
Total		**--**	**30**	**--**	**15**	**15**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract/Oral	Total
		Internal Assessment			End SemExam			
		Test1	Test 2	Avg				
HPES301	Seminar*	--	--	--	--	50	50	100
HPED301	Dissertation I	--	--	--	--	100	--	100
Total			**--**	**--**	**--**	**150**	**50**	**200**

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
HPED401	Dissertation II	--	30	--	15	15
Total		**--**	**30**	**--**	**15**	**15**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract/Oral	Total
		Internal Assessment			End SemExam			
		Test1	Test 2	Avg				
HPED401	Dissertation II*	--	--	--	--	100	100	200
Total		**--**	**--**	**--**	**--**	**100**	**100**	**200**

*** Seminar of Semester III and Dissertation II of Semester IV should be assessed jointly by the pair of Internal and External Examiners**

Note- The Contact Hours for the calculation of load of teacher are as follows
Seminar - 01 Hour / week / student
Dissertation I and Dissertation II - 02 Hour / week / student

Course Code	Course Name	Credits
HPEC101	**Advanced Heat Transfer#**	**04**

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 its application.
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.	08
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 with spatial effects.	08
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.	10
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.	08
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 for absorbing and transmitting medium.	10
06	Numerical methods in heat conduction: Necessity, Limitations, Finite difference formulation of differential equations, Explicit, Crank Nicolson and Fully implicit schemes of descritisation, 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	08

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:
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 questions need to be solved.

References:

1. Yunus A Cengel and Afhin J Ghajar, Heat and Mass Transfer
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 Publishing Corporation
5. J P Holman, Heat transfer, McGraw Hill, Int.
6. Frank Kreith & John S Bohn, Principles of heat transfer, Cengage Learning India Pvt Ltd.
7. C P Kothandaraman, Fundamentals of heat and mass transfer, New Age International Publishers.
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
HPEC102	**Advanced Thermodynamics**	**4**

Objectives

1. Describe the concepts entropy and exergy and their use in analyses of thermal energy systems
2. Master the property equations and the methods for analyzing multi-component systems.
3. Acquire basic knowledge of chemical thermodynamics.

Outcomes: Learner will be able to…

1. Use exergy concept in the analysis of thermal systems.
2. Knowledge of phase equilibria in multi-component systems.
3. Ability to estimate thermodynamic properties of substances in gas or liquid state of ideal and real mixture
4. Have knowledge of contemporary issues related to chemical engineering thermodynamics

Module	Detailed Contents	Hrs
01	**Introduction**: Availability, Irreversibility and Second-Law Efficiency for a closed System and steady-state, control Volume. Availability Analysis of Simple Cycles. Thermodynamic Potentials, Maxwell relations, Generalized relation for changes in Entropy, Internal Energy and Enthalpy.	06
02	**Equation of State:** State postulate for Simple System and equation of state, Ideal gas equation, Deviation from ideal gas, Equation of state for real gases, generalized Compressibility chart, Law of corresponding states. Different Equations of State, Fugacity, Compressibility, Principle of corresponding States, Use of generalized charts for enthalpy and entropy departure, fugacity coefficient, Lee-Kesler generalized three parameter tables.	08
03	**Laws of thermodynamics:** 2 ndlaw Analysis for Engineering Systems, Entropy flow &entropy generation, Increase of entropy principle, entropy change of pure sub, T-ds relations, entropy generation, thermo electricity, Onsager equation. Exergy analysis of thermal systems, decrease of Exergy principle and Exergy destruction.	10
04	**Properties of Pure Substances**: Phase change process of pure substances, PVT surface, P-v &P- T diagrams, Use ofsteam tables and charts in common use **Thermodynamic Property Relations**: Partial Differentials, Maxwell relations, Clapeyron equation, general relations for du,dh, ds, and Cv and Cp, Joule Thomson Coefficient, _h, _u, _s of real gases.	08
05	**Chemical Thermodynamics**: Chemical reaction, Fuels and combustion, Enthalpy of formation and enthalpy ofcombustion, First law analysis of reacting systems, adiabatic flame temperature, Chemical and Phase equilibrium - Criterion for chemical equilibrium, equilibriumconstant for ideal gas mixtures, some remarks about Kp of Ideal-gas mixtures,fugacity and activity, Simultaneous relations, Variation of Kp with Temperature,Phase equilibrium, Gibb's phase rule, Third law of thermodynamics, Nerstheattheorem and heat death of universe	10
06	**Gas Mixtures** – Mass & mole fractions, Dalton's law of partial pressure, Amagat'slaw, Kay's rule. **Statistical Thermodynamics**- Fundamentals, equilibrium distribution, Significance of	10

	Lagrangian multipliers, Partition function for Canonical Ensemble, partition function for an ideal monatomic gas, equi-partition of energy, Bose Einstein statistics, Fermi-Dirac statistics.	

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:
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 questions need to be solved.

References:

1.Howell&Dedcius: Fundamentals of engineering Thermodynamics, McGraw Hill,Inc, USA
2. Holman, Thermodynamics, 4 th edition, McGraw Hill
3. Zimmansky&Dittman, Heat and Thermodynamics, 7 th edition, TMH
4. Rao, Y.V.C., Postulational and Statistical thermodynamics, Allied Pub. Inc
5. Jones and Hawkings: engineering Thermodynamics, john Wiley & Sons, Inc. USA
6. Faires V. M. and Simmag: Thermodynamics. McMillan Pub. Co. Inc. USA
7. Turns, Thermodynamics- Concepts and Applications, Cambridge University Press
8. Wark, Advanced Thermodynamics, McGraw Hill
9. Jones &Dugan, Advanced Thermodynamics, Prentice Hall Int.
10. Bejan, Advanced Thermodynamics, John Wiley, Inc. 14. Kenneth WarkJr.,Advanced
11. Thermodynamics for Engineers, McGraw-Hill Inc., 1995.
12. DeHotf,R.T. Thermodynamics in Materials Science, McGraw-Hill Inc.,
13. Winterbone DE, Advanced thermodynamics for engineers, Arnold 1997.
14. Nag P.K., Basic & Applied Thermodynamics, TMH, New Delhi.
15. Cengel, Thermodynamics, TMH
16. Van Wylen& Sontag: Thermodynamics, John Wiley & Sons, Inc., USA
17. Sonntag, R.E., and Vann Wylen, G, Introduction to Thermodynamics, Classical and Statistical,third Edition, John Wiley and Sons, 1991.

Course Code	Course Name	Credits
HPEC103	**Gas Turbine and Steam Turbine**	**4**

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 steam 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	10
02	Steam turbine auxiliary systems: turbine protective devices, tripping devices, unloading gears, lubricating systems, glands and sealing systems	10
03	Construction, Operation and Maintenance of Steam Turbines	06
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,	10
05	Combustion chambers, requirements, types, factor affecting performance of CC, performance of turbines	06
06	GT auxiliary systems, operation and maintenance, starting and ignition systems, lubrication systems, Fuel system and controls, operation, maintenance and trouble shooting	10

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 or Visit to Refrigeration Plat.

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 questions need to be solved.

References:

1. Lee J F, Theory and Design of Steam and Gas Turbines, McGraw-Hill, New York
2. Gas Turbine Engineering Handbook, Meherwan P Boyce, Gulf Publishing Company.
3. Cohen, H., Rogers, G.E.C., and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman Group Ltd, 1989
4. Gordon C, Dates, Aero-thermodynamics of Gas Turbine and Rocket Propulsion AIAA Education Series, NY, 1984.
5. R Yadav, Steam and Gas Turbines and Power Plant Engineering, Central Publishing House, Allahabad, 2004
6. Ganesan, V., Gas Turbines, Tata McGraw-Hill Pub.Co.Ltd., New Delhi, 1999

Course Code	Course Name	Credits
HPEDLO 1011	**Utilization of Solar Energy**#&	**4**

Objectives

1. To understand Solar Geometry and basic idea of solar energy collection
2. To learn different utilities of solar energy
3. To summarise economics of solar energy collection systems

Outcomes: Learner will be able to…

1. Estimate and quantify available solar radiation
2. Judiciously design the solar energy collection system
3. Understand basic economics ofsolar energy systems

Module	Detailed Contents	Hrs.
01	Description of Solar Radiation and its application for thermal utilities as well as PV utilities, availability, measurement and estimation; Isotropic and anisotropic models; empirical relations	10
02	Flat plate collector, concentrating collector, thermal energy storage: steady state and dynamic analysis, process economics	08
03	Solar water heating: active and passive, building heating and cooling, solar drying, solar desalination, Solar Ponds, Industrial Process heating	08
04	Simulation in solar process design, limitations of simulation, design of active systems by f-chart, utilizability method	08
05	Solar photovoltaic systems, PV generators: characteristics and models, load characteristics and direct coupled systems, maximum power point trackers, applications, design procedure , applications of nano materials/technology in solar energy	10
06	Solar Economics: Application of economic methods to analyze the feasibility of solar systems to decide project/policy alternatives, Net energy analysisand cost requirements for active and passive heating and cooling, electric power generation and for industrial process heating	08

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 or Visit to Refrigeration Plat.

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 questions need to be solved.

References:

1. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, third edition, Tata McGraw-Hill, New Delhi.
2. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, second edition, John Wiley, New York, 1991.
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
4. M. S. Sodha, N. K. Bansal, P. K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive Building: science and design, Pergamon Press, New York, 1986.
5. M. A. S. Malik, G. N. Tiwari, A. Kumar and M.S. Sodha, Solar Distillation. Pergamon Press, New York, 1982.

Course Code	Course Name	Credits
HPEDLO 1012	**Cogeneration and Waste Heat Recovery Systems#&**	**4**

Objectives

1. To understand cogeneration and waste heat recovery techniques
2. Learn to check viability of cogeneration and waste heat recovery
3. To summarise 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	08
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	14
03	**Waste heat recovery:** Introduction - Principles of Thermodynamics and Second Law - sources of Waste Heat recovery - Diesel engines and Power Plant etc.Vapour absorption system working on waste.	08
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	10
05	**Applications & techno economics of waste heat recovery systems:** Applications in industries, selection of waste heat recovery technologies - financial considerations - operations and investment costs of waste heat recovery	08
06	**Introduction to tri-generation and quad-generation**	04

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 or visit to Refrigeration Plat.

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 questions need to be solved.

References:

1. Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
2. Horlock JH, Cogeneration-Heat and Power, Thermodynamics and Economics, Oxford, 1987.
3. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.
4. SenguptaSubrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.
5. De Nevers, Noel., Air Polllution Control Engineering, McGrawHill, New York,1995.
6. I. Pilatowsky, R.J. Romero, C.A. Isaza, S.A. Gamboa, P.J. Sebastian, W. Rivera, Cogeneration Fuel Cell-Sorption Air Conditioning Systems (Green Energy and Technology), Springer

Course Code	Course Name	Credits
HPEDLO 1013	**Alternative Fuels#&**	**4**

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 of Alternative fuels, Types, Advantages, Sources of Alternative fuels.	10
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.	12
03	**Advanced Gaseous fuels** Bio-CNG from sugarcane, Synthetic gas SynGas, generation of SynGas through plasma gasification of plastic waste, Applications.	08
04	**Hydrogen Technology** Hydrogen as Alternative fuel, Hydrogen storage, hydrogen liquefaction, ortho and para hydrogen, Non-fossil Natural gas and methane, Applications.	08
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 cell systems, Applications.	08
06	**Alternative Fuels and Environmental Impact** Climate change, Benefits of alternative fuel to environment, Environmental impact assessment.	06

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 or Visit to Refrigeration Plat.

End Semester Theory Examination:

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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 questions need to be solved.

References:

1. Sunggyu Lee, Alternative Fuels, Applied Energy Technology Series, CRC Press
2. Sunggyu Lee, James G. Speight, Sudarshan K. Loyalka, Handbook of Alternative Fuel Technologies, CRC Press
3. Vishwanathan B and M Aulice Scibioh, Fuel Cells, Universities Press, Hyderabad, 2006
4. Gupta R B,Hydrogen fuel:Production, transport and storage, Boca Raton : CRC Press, 2008
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6. Michael Frank Hordeski, Alternative Fuels-The Future of Hydrogen, The Fairmont Press, Inc., CRC Press
7. G.N. Tiwari, M.K. Ghosal, Fundamentals of Renewable Energy Sources, Alpha Science Intnl. Ltd., 2007
8. Prabir Basu; Biomass gasification and pyrolysis: Practical design and theory; Elsevier, 2010
9. Sergio Capareda, Introduction to Biomass Energy Conversions, CRC Press, 2013
10. H S Mukunda, Understanding Clean Energy and Fuels from Biomass, Wiley India
11. Sobh Nath Singh, Non-Conventional Energy Resources, Pearson Education
12. Nijaguna, B.T., Biogas Technology, New Age International publishers (P) Ltd.
13. Alternative Fuel, Edited by Maximino Manzanera, ISBN 978-953-307-372-9, Publisher InTech, Published August 09, 2011 under CC BY-NC-SA, Edited Volume, Open Access, http://www.intechopen.com/books/alternative-fuel

Course Code	Course Name	Credits
HPEDLO 1014	**Design of Refrigeration and Air conditioning Systems**	**04**

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 content	Hours
01	**Vapour Compression refrigeration-** Multi-evaporator system;Multi expansion system; Cascade systems; Study of P-h; T-s; h-s and T-h charts for various refrigerants, Heat Pumps-circuits,industrial application & future role	06
02	**Vapour absorption refrigeration**- Standard cycle and actual cycle, thermodynamic analysis, Li-Br-water, NH3- water systems, Three fluid absorption systems, half effect, single effect, double effect, and triple effect system. Non-conventional refrigeration system (Principle and thermodynamic analysis only)- Thermoelectric refrigeration, Pulse Tube refrigeration ,steam jet refrigeration, vortex tube refrigeration,	10
03	**System Components & Accessories,Controls**- Refrigeration Compressors-Different types& capacity control, Evaporators - different types & application, Condensers-Types, Economical water rate & velocity ,Cooling Tower- Range & approach, Expansion Devices,Accessories & Controls-oil separator,drier, Receiver, HP-LP cut out,Thermostats, relief valves, safety valves	08
04	**Air Conditioning Technology: Load Estimation and Air Distribution**:- study of various sources of the internal and external heat gains, solar heat gain, Load from - occupants, equipment, infiltration air, miscellaneous heat gain , heat load calculations, RSHF, GSHF, ESHF etc. Inside and outside design conditions, Duct-pressure drop calculations, design ducts by different duct design methods, duct layout patterns. Air distribution systems–types, ventilation systems- types ,Types of grills, diffusers, wall registers, etc.	10
05	**Air Conditioning equipment & Control system**:- humidifiers, dehumidifiers, air filters, air washers, Fans andBlowers-types, performance characteristics, series and parallel arrangement, selection procedure ,Basic elements of control system, thermostat, humidistat, control system used for winter & summer air conditioning	08
06	**Direct and Indirect Evaporative Cooling and Air conditioning systems-** Basic psychometric of evaporative cooling, Thermodynamics of evaporative cooling, types of evaporative coolers,design calculations, indirect evaporative cooling for tropical countries. Air conditioning systems- Classification, constructional details- window,package, split,central units. Typical air conditioning systems such as automobile, air plane, ships, railway coach air-conditioning,Industrial refrigeration applications,medical application etc. warm air system, hot water systems, heat pump, clean rooms (descriptive treatments only). **Standards and Codes**: ASHRAE/ARI, BIS standards study and interpretation,ECBC, NBC codes	10

Assessment:

Internal:
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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 questions need to be solved.

References:

1. R.J. Dossat, Principles of refrigeration, Pearson Education Asia
2. C.P. Arora, Refrigeration and Air-Conditioning
3. Stoecker and Jones, Refrigeration and Air-conditioning
4. Jordan and Priester, Refrigeration and Air-conditioning
5. A.R. Trott, Refrigeration and Air-conditioning, Butterworths
6. J.L. Threlkeld, Thermal Environmental Engineering, Prentice Hall
7. W.F. Stoecker, Industrial Refrigeration Handbook, McGraw-Hill
8. Langley, Billy C., 'Solid state electronic controls for HVACR' pentice-Hall 1989.
9. John A. Corinchock, Technician's guide to Refrigeration systems, McGraw-Hill
10. P.C. Koelet, Industrial Refrigeration: Principles, design and applications, McMillan.
11. Handbook of Air Conditioning System Design, Carrier Incorporation, McGraw Hill Book Co., USA.
12. Domkundwar,Arora, A course on refrigeration & air conditioning – DhanpatRai& sons
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15. Hainer R. W., Control System for Heating, Ventilation and Air conditioning, Van
16. Nastrand Reinhold Co., New York, 1984.
17. ASHRAE Handbooks
19. Refrigeration Handbook, Wang, McGraw Hill, Int.
20 .Edward G.Pita, Air conditioning principles and systems ,Prentice Hall

Course Code	Course Name	Credits
ILO 1011	Product Life Cycle Management	03

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 moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**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	10
02	**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	09
03	**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	05
04	**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	05
05	**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	05

06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of LCA, 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	05

Assessment:

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

End Semester Theory Examination:
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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, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, 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
ILO 1012	Reliability Engineering	03

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 complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. 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
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, 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, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**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.	05
06	**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	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test 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
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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. 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
ILO 1013	Management Information System	03

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
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	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
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:

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End Semester Theory Examination:

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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
ILO 1014	Design of Experiments	03

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 designs for 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 appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design	07

	4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

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End Semester Theory Examination:
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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, Innovation and 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
ILO 1015	Operations Research	03

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 linear program 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 optimal solution 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 important performance measures

Module	Detailed Contents	Hrs
01	**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's approximation 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 m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**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	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with	05

	saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test 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.**

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2. All question carry equal marks
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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", John Willey 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
ILO 1016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:
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4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, SunitBelapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security* &*Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO 1017	Disaster Management and Mitigation Measures	03

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 the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction ***1.1*** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 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 level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 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 how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance 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. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06

05	Financing Relief Measures: 5.1 Ways 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. 5.2 International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test 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 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, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier 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, Rawat Publications
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 information available on authentic web sites)

Course Code	Course Name	Credits
ILO 1018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy 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 energy saving 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	04
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)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments 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.	10
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.	10
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.	04

06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

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

End Semester Theory Examination:
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1. Question paper will comprise of total six question
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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. 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 Research Institute (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
HPEL101	**Laboratory I- Simulation of Thermal systems**	**01**

Simulation study using mathematical simulation software (or any programming language) on any six

1. Performance test on Spark Ignition engines using Alternate fuels such as ethanol and LPG.
2. Simulation studies of Vapour Absorption System.
3. Simulation studies of Petrol and Diesel engine cycles.
4. Simulation of Gas Turbine Cycles.
5. Simulation of Adiabatic flame temperature in constant volume heat addition process.
6. Simulation of Adiabatic flame temperature in constant pressure heat addition process
7. Calibration of a cryogenic temperature-measuring instrument.
8. Trial / Design of Sterling cycle refrigerator.
9. 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
HPEL102	**Laboratory II -Refrigeration and Air conditioning Technologies**	**01**

MODULE	Detailed content
01	Trial on VCC as Heat pump Trial on VCC- Effect of condensing and evaporator temperature on Performance
02	Trial on Water cooling tower apparatus. Design air conditioning system with system selection, load estimation, duct design, Equipment selection, Control systems, lay out diagrams (line sketches) for any one application from:,Departmental store, Restaurant, Auditorium, Computer lab, Theater etc.
03	Visit report on (Any one) or Presentation on (Any one) a) Cold Storage b) Ice Plant c) Dairy d) Pharmaceutical

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Course Code	Course Name	Credits
HPEC201	**Modelling and Analysis in Thermal Engineering#**	**4**

Objectives

1. Differenciate design and analysis
2. Understand problem formulation and various modelling and simulation methods to optimise the solution

Outcomes: Learner will be able to…

1. Identify design parameters of basic thermal systems
2. Formulate the problem and propose the solution

Module	Detailed Contents	Hrs.
01	Introduction, Design versus analysis, need for optimization, basic characteristics of thermal 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	10
02	Modeling of thermal systems, basic considerations in design, importance of modeling in design, types of models, mathematical modeling, physical modeling and dimensional analysis	10
03	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	08
04	Economic considerations, calculation of interest, worth of money as a function of time, raising capital, economic factors in design, application to thermal systems	08
05	Problem formulation for optimization, basic concepts, optimization methods, optimization of thermal systems, practical aspects in optimal design	08
06	Knowledge based design and additional considerations, knowledge based systems, additional constraints, sources of information	08

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 or Visit to Refrigeration Plat.

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 questions need to be solved.

References:

1. Yogesh Jaluria, Design and Optimization of Thermal Systems, McGraw-Hill international editions, 1998
2. Stocker W, Modelling of thermal systems,
3. Eckert E R G and Drake R M,Analysis of Heat and Mass Transfer, McGraw-Hill, New York, 1972
4. SzucsE,Similitude and Modeling, Elsevier, New York, 1977
5. Wellstead P E,Introduction to Physical System Modeling, Academic Press, New York, 1979
6. Chapra S C and Canale R P,Numerical Methods for Engineers, McGraw-Hill, New York, 1988
7. Atkinson K,An Introduction to Numerical Analysis, Wiley, New York, 1978

Course Code	Course Name	Credits
HPEC202	**Advanced Fluid Mechanics**	**4**

Objectives

1. Understand governing equations of motion and N-S equation
2. Understand boundrey layer concept in turbulant as well as laminar flow regime
3. Knowledge of compressible fluid flow

Outcomes: Learner will be able to…

1. Find exact solution of Navier Stokes equations
2. Implement compressible flow concept to real life problems

Module	Detailed content	Hours
01	**Basic Concepts and Fundamentals:** Properties of Fluids, Continuum, Langragian and Eulerian description, Velocity and Stress field, Fluid statics, Fluid Kinematics.	5
02	**Governing Equations of Motion**: Reynolds's Transport Theorem (RTT), Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Euler's equation, Navier-Stokes equations, Bernoulli's Equation.	10
03	**Exact solutions of Navier - Stokes Equations:** Couette flows, Poiseuile Flows (Plane,Hagen) , Fully developed flows in channel, flow between concentric rotating cylinders, Stokes First problem (Unsteady flow), Creeping flow.	07
04	**Laminar Boundary Layers**: 4.1 Boundary layer equations, flow over a flat plate, similarity (Blasius) solution, Falkner-Skan equation, momentum integral method,Approximate Methods, Flow separation, Entry flowinto a duct. 4.2 External flows: drag, lift,	08
05	**Turbulent flow:** 5.1 Introduction to hydrodynamic stability, characteristics of turbulence, governing equations, turbulent boundary layer, algebraic models (Prandtl's mixing length) and velocity profile over a flat plate and in pipes. 5.2 Turbulent Shear Flows: Equations for free shear layers: mixing layer, plane and axis symmetric jet, wake. Turbulent energy equation, two equation model (k-epsilon, k-omega), Large Eddy Simulation, Various Turbulent Models.	12
06	**Compressible Flow:** 6.1 One-dimensional Flow: speed of sound, variable cross-section flow, converging diverging nozzle, effect of friction and heat transfer, normal shock relations, introduction to oblique shocks, Two-dimensional flows (subsonic and supersonic) past slender bodies, compressible boundary layers. 6.2 Shocks: Normal and oblique shocks, Prandtl – Meyer expansion, Rankine – Hugnoitrelation, Application of method of characteristics applied to two dimensional cases, simple supersonic wind tunnel, Design of supersonic wind tunnel and nozzle.	10

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:
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 questions need to be solved.

References:

1. Introduction to Fluid Mechanics and Fluid Machines by S K Som and Gautam Biswas, Tata McGraw-Hill, Revised Second Edition, 2007.
2. Advanced Fluid Mechanics, G. Biswas and K. Muralidhar, Narosa Publishing, 2005.
3. Fluid Mechanics, Frank M. White, Tata McGraw-Hill, Singapore, Sixth Edition, 2008.
4. Fluid Mechanics, Cengel, Tata McGraw Hill
5. Viscous Fluid Flow, Frank M. White, 2nd ed., McGraw-Hill, 1991.
6. Boundary Layer Theory, H. Schlichting, McGraw-Hill Inc.,
7. A First Course in Turbulence, Tennekes H. and Lumley J.L., The MIT press, 1972.
8. Turbulent Flow, R. J. Garde, 2nd Edition, New Age International Publishers.
9. The Dynamics of Compressible flow ,Shapiro A F Vol 1, The Ronald Press Company 1963
10. Modern Compressible Flow with Historical Perspective, John D. Anderson, McGraw Hill.

Course Code	Course Name	Credits
HPEC203	**Heat Exchanger Design and Performance #**	**04**

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.
01	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	10
02	Flow Distribution and Stress Analysis: Effect of Turbulence –Effect of Fouling-Friction Factor - Pressure Loss - Channel Divergence Stresses in Tubes - Heater sheets and Pressure Vessels - Thermal Stresses - Shear Stresses - Types of Failures	8
03	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	10
04	Condensers and Evaporators Design: Design of Surface and Evaporative Condensers - Design of Shell and Tube - Plate Type Evaporators	8
05	Cooling Towers: Types- Spray Design - Selection of Fans- Testing and Maintenance of cooling towers, Compact cooling towers, cooling tower performance variable	8
06	Design of Special Purpose Heat Exchangers: corrosive environment. Marine/space applications, compact heat exchanger	8

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:

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.**

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2. All question carry equal marks
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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. W. M. Kays and A. L. London,Compact heat exchanger,
4. Mojtaba Sabet,Cooling tower fundamentals and best design practices,
5. T. Taborek, G.F. Hewitt and N.Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980
6. Walker, Industrial Heat Exchangers - A Basic Guide, McGraw Hill Book Co., 1980
7. Nicholas Cheremisioff, Cooling Tower, Ann Arbor Science Pub 1981
8. Arthur P. Fraas, Heat Exchanger Design, John Wiley & Sons, 1988

Course Code	Course Name	Credits
HPEDLO 2021	**Cryogenics#**	**04**

Objectives

1. Impart basic knowledge of low temperature generation, difficulties in maintaining low temperature and solutions
2. Understand applications of cryogenic refrigeration
3. Understand storage of cryogenic liquids and equipments, instruments used

Outcomes: Learner will be able to…

1. Understand use of cryogenic systems, realtime difficulties in storaing cryogenic liquids
2. Identify effects of verious components on cryogenic system performance

Module	Detailed content	Hrs
01	**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
02	**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 - Recuperative -Collins, Simon; Regenerative – Sterling cycle and refrigerator,Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas	10
03	**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
04	**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
05	**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 cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system ,Cool-down of storage and transfer systems	08
06	**Cryogenic equipments & 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,system optimization, cryocoolers	08

	Cryogenic Applications- Cryogenic Engineering applications in energy, aeronautics, space,industry, biology& medicine,food preservation, Transport, Cryopumping;	

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:
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4. Only Four questions need to be solved.

References:

1. Klaus D. Timmerhause and Thomas M Flynn, Cryogenic Process Engineering, Plenum Press, 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
HPEDLO 2022	**Computational Fluid Dynamics& Heat Transfer**	**04**

Objectives

1. To understand Solar Geometry and basic idea of solar energy collection
2. To learn different utilities of solar energy
3. To summarise economics of solar energy collection systems

Outcomes: Learner will be able to…

1. Estimate and quantify available solar radiation
2. Judiciously design the solar energy collection system
3. Understand basic economics of solar energy systems

Module	Detailed Content	Hrs
01	**Introduction to CFD and the Governing Equations of Fluid Dynamics:** Historical background, Impact of CFD, Derivation, Discussion of physical meanings, and presentation of forms particularly suitable to CFD.	04
02	**Basic Aspects of Discretization:** Introduction to Finite Difference, Finite Elements and Finite Volume Methods. Detailed treatment of Finite Difference method, explicit and implicit methods, errors and stability analysis. **Grids with Appropriate Transformations** Adaptive grids and unstructured meshes. Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.	08
03	**Few CFD Techniques** The Lax-Wendroff Technique, MacCormack's Technique, Space marching, Relaxation Technique, Numerical dissipation and dispersion, Artificial viscosity, The ADI Technique, Pressure correction Technique: Application to incompressible viscous flow, the SIMPLE algorithm. SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, Finite deference approach.	10
04	**Numerical Solution of Governing equations:** Numerical solution of elliptical equations - Linear system of algebraic equations – Iterative solution of system of linear equation. Model Equations, Wave equations, Numerical solution of parabolic equations, Stability analysis,Advanced shock capturing schemes. Solutions of convection, Diffusion equation, Conservative and non-conservative schemes, concept of artificial viscosity and Numerical Diffusion.Navier-Stokes equations and algorithms; Basics of grid generation, Numerical solution ofhyperbolic equations - Burgers equation generation.	10
05	**Convection Heat Transfer And FEM**: Steady One-Dimensional and Two-Dimensional Convection - Diffusion, Unsteady one-dimensional convection - Diffusion, Unsteady two-dimensional convection - Diffusion - Introduction to finite element method - Solution of steady heat conduction by FEM - Incompressible flow - Simulation by FEM.	10
06	**Incompressible Couette Flow** Solution by implicit method and the pressure correction method, Governing Equations, Stream Function - Vorticity method, Determination of pressure for viscous flow,	10

	Turbulence Models: Algebraic Models - One equation model, K-I Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes. **Numerical Solution of a 2D Supersonic Flow** Prandtl-Meyer Expansion Wave **Supersonic Flow over a Flat Plate** Numerical Solution by solving complete Navier Stokes equation.	

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:
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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 questions need to be solved.

References:

1. John D. Anderson Jr., “Computational Fluid Dynamics-The Basics with Applications”, McGraw Hill. Inc.,
2. Fletcher C.A.J. “Computational Techniques for Fluid Dynamics”, Volumes I and II, Springer, Second Edition [2000].
3. C. Hirsch, “Numerical Computation of Internal and External Flows”, Volumes I and II, John Wiley & Sons [2001]
4. Tannehill J. C., Anderson D.A., and Pletcher R.H., Computational Fluid Mechanics and Heat Tran5fer, 2nd ed., Taylor & Francis, 1997.
5. Hoffmann, K.A. and Chiang, S.T., Computational Fluid Dynamics for Engineers, Engineering Education Systems, 2000.
6. Peyret, R. and Taylor, T. D., Computational Methods for Fluid Flow, Springer-Verlag, 1983.
7. MuralidharK.andSundararajanT., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi1995.
8. GhoshdasdidarP.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
9. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation
10. Taylor, C and Hughes J.B.,Finite Element Programming of the Navier Stock Equation, Pineridge Press Ltd., U.K.1981.

Course Code	Course Name	Credits
HPEDLO 2023	**Advanced Turbo Machinery#**	**04**

Objectives

1. Study basic concepts and principles of turbo machinery
2. Learn performance analysis of cenrtifugal as well as axial machines like fans, blowers and compressors

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. Indetify suitable control and testing methods for blowers and fans

Module	Detailed Contents	Hrs.
01	**Basic concepts of Turbo Machines:** Definition of Turbomachine, classification; Euler's pump equation and Euler's turbine equation, dimensional analysis applied to hydraulic machines and compressible flow machines.	07
02	**Principles of Turbo Machinery:** Transfer of energy to fluids, Performancecharacteristics, fan laws, selection of centrifugal, axial, mixed flow, Axial flow machines	08
03	**Analysis of Centrifugal Machines:** Centrifugal Compressors and Blowers: Theoretical characteristic curves, Eulers characteristics andEulers velocity triangles, losses and hydraulic efficiency, flow through inlet nozzle, impeller, diffusers, casing, leakage, disc friction, mechanical losses, cross flow fans	10
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	12
05	**Design and Applications of Blowers and Fans:** Special design and applications of blower induced and forced draft fans forair-conditioning plants, cooling towers, ventilation systems, booster systems.	09
06	**Testing and control of Blowers and Fans:** Performance testing, noise control, speedcontrol, throttling control at discharge and inlet.	06

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:

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.**

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2. All question carry equal marks
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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. Dixon. Worked examples in turbomachinery, Pergamon Press, 1984.
6. BudugurLakshminarayana, Fluid Dynamics and heat Transfer of Turbomachinery, John Wiley 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, AijazKhan,Turbomachinery Design and Theory, Marcel Dekker, Inc, New York

Course Code	Course Name	Credits
HPEDLO2024	**Non-Conventional Power Plants#**	**04**

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

Module	Detailed Contents	Hrs.
01	Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy.	08
02	Solar thermal power plants (Concentrators, solar chimney etc.), Solar thermal conversion 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	10
03	Wind energy: Wind energy potential measurement, wind electric generator component design, economics and demand side management, energy wheeling, and energy banking concepts.	10
04	Biogas: properties of biogas (Calorific value and composition), biogas plant technology and status	08
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.	08
06	Environmental impacts, Economic and social considerations, Financing mechanisms,Carbon credits, clean development mechanisms	08

Assessment:

Internal:

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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:

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 questions need to be solved.

References:

1. S.P.Sukhatme, Solar Energy – Principles of thermal collection and storage, II edition, Tata McGraw Hill, New Delhi, 1996.
2. J.A.Duffie and W.A.Beckman, Solar engineering of Thermal processes, II edition, John Wiley, New York, 1991.
3. D.Y.Goswami, F.Kreith and J.F.Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
4. D.D.Hall and R.P.Grover, Biomass Regenerable Energy, John Wiley, New York, 1987.
5. Mukund R Patel, Wind and Solar Power Systems, CRC Press, 1999.
6. J F Manwell, J.C.McGowan, A.L.Rogers, Wind Energy Explained: Theory, Design and Application, John Wiley and Sons, May 2002.
7. R D Begamudre, Energy Conversion Systems, New Age International (P) Ltd., Publishers, New Delhi ,2000.

Course Code	Course Name	Credits
ILO 2021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about 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 them strategically.
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
01	**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
02	**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
03	**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
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**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	6

	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.	

Assessment:

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End Semester Theory Examination:

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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 questions need to be solved.

References:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management 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
ILO 2022	Finance Management	03

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 its management
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
01	**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 Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**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
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working 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
05	**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

06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

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:

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1. Question paper will comprise of total six question
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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 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: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO2023	Enterpreneurship Development and Management	03

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
01	**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	04
02	**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	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**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	08
05	**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	08
06	**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 business Critical Success factors of small business	05

Assessment:

Internal:

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End Semester Theory Examination:

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4. Only Four questions need to be solved.

References:

1. PoornimaCharantimath, 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. MaddhurimaLall, ShikahSahai, 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. LaghuUdyogSamachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO2024	Human Resource Management	03

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
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR 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
02	**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 Behavioral Change (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
03	**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, Tactics and strategies.	6

04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool 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
06	**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	10

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:

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4. Only Four questions need to be solved.

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, Himalaya Publishing, 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
ILO2025	Professional Ethics and Corporate Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**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	04
02	**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	08
03	**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
04	**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	05
05	**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	08
06	**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.	08

Assessment:

Internal:

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End Semester Theory Examination:

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4. Only Four questions need to be solved.

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 BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO2026	Research Methodology	03

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
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**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**
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

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:

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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 Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2^{nd}ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO2027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
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 Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category 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
02	**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
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	**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
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**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:

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:

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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 on Patent 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: Current Trends 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, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi**,** IPR: Drafting,Interpretation of Patent Specifications 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
ILO 2028	**Digital Business Management**	**03**

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 content	Hours
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 EC and 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, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	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 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	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal 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:

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:

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 questions need to be solved.

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 theory and 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
ILO2029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise 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
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	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.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	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.	03

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:

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 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, Edward Elgar 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
HPEL201	**Laboratory III- Computational Fluid Dynamics**	**01**

Module	Detailed contents
1	**Simulation studyusing mathematical simulation software (or any programming language) on** • Steady state conduction in solids • Steady state convection in solids • Steady state radiation in solids
2	**Simulation study using finite element software on** • Combined conduction and convection • Unsteady state conduction and convection • Unsteady state conduction and radiation
3	**Simulation study usingFEM, FDM and FVM** • Steady state conduction in fluids • Steady state convection in fluids • Two phase flows • Condensation and boiling heat transfer

Note: Software used should be Fluent/Star CD/ANSYS/CFX user defined codes

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal andexternal examiners

Course Code	Course Name	Credits
HPEL202	**Laboratory IV- Energy Audit**	**01**

Experiments and Case Studies on

1. Finding energy saving potential from specific power consumption and EER of Air conditioner.
2. Illuminance calculation and lighting design for an interior.
3. Centrifugal Pump efficiency calculation and ENCON opporunities.
4. 3-Φ/1-Φ motor loading calculation and ENCON opporunities.
5. Fan/Blower efficiency calculation and ENCON opporunities.
6. Performance testing of Air compressor and ENCON opporunities.
7. Leakage testing of Air compressor and ENCON opporunities.
8. Study of an Electricity bill and ENCON opporunities

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
HPES301	**Seminar**	**03**

Guidelines for Seminar

- Seminar should be based on thrust areas in Mechanical Engineering (Heat Power aspect is appreciated)
- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literature and understand the topic and compile the report in standard format as per University Guidelines for report writing and present in front of Panel of Examiners appointed by the Head of the Department/Institute of respective Programme.
- **Seminar should be assessed jointly by the pair of Internal and External Examiners**
- Seminar should be assessed based on following points
  - Quality of Literature survey and novelty in the topic
  - Relevance to the specialization
  - Understanding of the topic
  - Quality of Written and Oral Presentation

Subject Code	Subject Name	Credits
HPED301/ HPED401	**Dissertation (I and II)**	**12 + 15**

Guidelines for Dissertation

- 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 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
  - Validation of results
  - Quality of Written and Oral Presentation
- Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai

Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)

Desertation Report has to be prepared strictly as per University of Mumbai report writing guidelines.