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UNIVERSITYOFMUMBAI

Revised Syllabus for the M. E. Program

Program: M. E. (Mechanical)

ENERGY SYSTEMS AND MANAGEMENT

(As per **Choice Based Credit System** 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 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 (Energy Systems and Management)
Mumbai University
(With Effect from 2016-2017)

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
ESMC101	Energy Scenario, Policy and Environment	04	--	04	--	04
ESMC102	Energy Efficiency in Thermal Systems	04	--	04	--	04
ESMC103	Conventional Power Plants	04	--	04	--	04
ESMDLO 101X	Department Level Optional Course I	04	--	04	--	04
ILO101X	Institute Level Optional Course I	03	--	03	--	03
ESML101	Laboratory I - Energy System Modelling and Simulation Lab	--	02	--	01	01
ESML102	Laboratory II - Energy Audit Lab	--	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					
ESMC101	Energy Scenario, Policy and Environment	20	20	20	80	03	--	--	100
ESMC102	Energy Efficiency in Thermal Systems	20	20	20	80	03	--	--	100
ESMC103	Conventional Power Plants	20	20	20	80	03	--	--	100
ESMDLO 101X	Department Level Optional Course I	20	20	20	80	03	--	--	100
ILO101X	Institute Level Optional Course I	20	20	20	80	03	--	--	100
ESML101	Laboratory I - Energy System Modelling and Simulation Lab	--	--	--	--	--	25	25	50
ESML102	Laboratory II - Energy Audit Lab	--	--	--	--	--	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
ESMDLO1011	Utilization of Solar Energy #&	ILO1011	Product Lifecycle Management
ESMDLO1012	Cogeneration and Waste Heat Recovery Systems #&	ILO1012	Reliability Engineering
ESMDLO1013	Alternative Fuels #&	ILO1013	Management Information System
ESMDLO1014	Energy SystemsModeling and Analysis	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 Energy Systems and Management and Thermal Engineering
& Common with Energy Systems and Management and Heat Power Engineering

Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
ESMC201	Advances in Energy Management and Audit	04	--	04	--	04
ESMC202	Energy Efficiency in Electrical Systems	04	--	04	--	04
ESMC203	Renewable & Sustainable Energy Systems	04	--	04	--	04
ESMDLO 202X	Department Level Optional Course II	04	--	04	--	04
ILO202X	Institute Level Optional Course II	03	--	03	--	03
ESML201	Laboratory III - Renewable Energy Lab	--	02	--	01	01
ESML202	Laboratory IV - Measurement & Virtual Instrumentation Lab	--	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					
ESMC201	Advances in Energy Management and Audit	20	20	20	80	03	--	--	100
ESMC202	Energy Efficiency in Electrical Systems	20	20	20	80	03	--	--	100
ESMC203	Renewable & Sustainable Energy Systems	20	20	20	80	03	--	--	100
ESMDLO 202X	Department Level Optional Course II	20	20	20	80	03	--	--	100
ILO202X	Institute Level Optional Course II	20	20	20	80	03	--	--	100
ESML201	Laboratory III - Renewable Energy Lab	--	--	--	--	--	25	25	50
ESML202	Laboratory IV - Measurement & Virtual Instrumentation Lab	--	--	--	--	--	25	25	50
Total			**100**	**100**	**400**		**50**	**50**	**600**

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

Course Code	Department Level Optional Course II	Course Code	Institute Level Optional Course II
ESMDLO2021	Energy Storage Systems	ILO2021	Project Management
ESMDLO2022	Fuels Combustion and Emission Control	ILO2022	Finance Management
ESMDLO2023	Energy Measurement and Control Instruments	ILO2023	Entrepreneurship Development and Management
ESMDLO2024	Energy Systems & Environmental Impact	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
ESMS301	Seminar*	--	06	--	03	03
ESMD301	Dissertation I	--	24	--	12	12
Total		**--**	**30**	--	**15**	**15**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract/Oral	Total
		Internal Assessment			End Sem Exam			
		Test1	Test 2	Avg				
ESMS301	Seminar*	--	--	--	--	50	50	100
ESMD301	Dissertation I	--	--	--	--	100	--	100
Total			**--**	**--**	**--**	**150**	**50**	**200**

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract/Oral	Total
ESMD401	Dissertation II*	--	30	--	15	15
Total		**--**	**30**	--	**15**	**15**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract/Oral	Total
		Internal Assessment			End Sem Exam			
		Test1	Test 2	Avg				
ESMD401	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
Project I and II - 02 Hour / week / student

Course Code	Course Name	Credits
ESMC101	Energy Scenario, Policy and Environment	04

Objectives

1. To understand and compare global and Indian energy profile.
2. To compare global and Indian energy policies.
3. To analyze energy impact on environment.

Outcomes: Learner will be able to…

1. Assess role of energy in global economic development.
2. Analyze energy consumption pattern in India and its effect on economic development.
3. Determine impact of International energy policy on national energy growth.
4. Understand relationship between energy, ecology and environment.

Module	Detailed Contents	Hrs.
01	**Global Energy Scenario** Role of energy in economic development and social transformation, Energy &GDP, GNP and its dynamics. Energy sources and overall energy demand and availability, Energy Consumption in various sectors and its changing pattern, Exponential increase in energy consumption and projected future demands. Non-Conventional and Conventional Energy Resources: Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar, wind and other renewable etc. Depletion of energy sources and impact on exponential rise in energy consumption on economies of countries and on international relations. Energy Security, Energy Consumption and its impact on environmental climatic change	10
02	**Indian Energy Scenario** Energy resources & Consumption, Commercial and noncommercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India and their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption. Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, Need for use of new and renewable energy sources, present status and future of nuclear and renewable energy, Energy Policy Issues related Fossil Fuels, Renewable Energy, Power sector reforms, restructuring of energy supply sector, energy strategy for future.	10
03	**International Energy Policy** International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries, EU Countries. International Energy Treaties (Rio, Montreal, Kyoto), Conference of Parties (COP), INDO-US Nuclear Deal. Future Energy Options, Sustainable Development, Energy Crisis, Role of International Energy Agency.	08
04	**Indian Energy Policy** Global energy issues, National & State level energy issues, National & State energy policy, Industrial energy policy, Energy security, Energy vision. Energy pricing & Impact of global variations. Energy productivity (National & Sector wise productivity). Energy Conservation Act-2001 & its features, Electricity Act-2003 & its features. Frame work of Central Electricity Authority (CEA), Central & States Electricity Regulatory Commissions (CERC & SERCs), Role of MoP(Ministry of Power) and BEE (Bureau of Energy Efficiency).	08

05	**Industrial Energy and Environment Analysis** Energy and the environment, Energy in manufacture, Hazardous waste management in Chemical/Petrochemical/Cement industries and Power Plants, Contamination of ground water, Treatment & disposal, Pollution from combustion and atmospheric pollution control methods.	06
06	**Energy, Ecology and Environment** Energy Conservation, Energy Efficiency, Concept of environment and ecology, various natural cycles in environment and ecology, effect of human activities on environment and ecology. Environmental Impact Assessment, Methodologies for environmental pollution prevention. Rules, regulations, laws etc. regarding environmental protection, pollution prevention and control, waste disposal etc. Role of government, semi/quasi govt. and voluntary organizations.	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. General Aspects of Energy Management and Energy Audit, Book 1, Bureau of Energy Efficiency India.
2. O'Callaghan Paul, Energy Management, McGraw Hill Book company, London, 1993.
3. A.P. Sincero, and G.A. Sincero, Environmental Engineering, Prentice Hall, New Jersey, 1996.
4. C.J., Barrow, Developing the Environment, Longman Scientific and Technical U.K., 1995.
5. R.Socolow, C. Andrews, F. Berkhout and V. Thomas, Industrial Ecology and Global change, Cambridge University Press, 1994.
6. Jose Goldemberg, A K N Reddy, Thomas Johnson, Energy for a sustainable world, Prienceton University
7. B V Desai, Energy policy, Weiley Eastern
8. J K Parikh, Modeling approach to long term demand and energy implication, IIASA Professional Paper
9. TEDDY Year Book Published by Tata Energy Research Institute (TERI),
10. S Rao, Energy Technology, Khanna Publishers
11. International Energy Outlook -EIA annual Publication
12. A.W. Culp, Principles of Energy Conversion, McGraw Hill International edition
13. Frank P Lees, Loss Prevention in Process Industries Volume 1, 2 & 3, Elsevier Butterworth Heinemann

Course Code	Course Name	Credits
ESMC102	**Energy Efficiency in Thermal Systems**	**04**

Objectives

1. To understand conventional and nonconventional fuels & combustion technology.
2. To discover energy conservation (ENCON) opportunities in thermal systems.
3. To know alternatives for waste energy recovery from energy systems.

Outcomes: Learner will be able to…

1. Define the reasons of incomplete combustion and attempt to reduce the subsequent impact.
2. Determine ENCON opportunities in thermal systems.
3. Measure and improve the quality of recovered waste energy.

Module	Detailed Contents	Hrs.
01	**Fuel and Combustion Technology** Introduction to Fuels, Properties of Fuel oil, Coal and Gas, Storage, handling and preparation of fuels, Principles of Combustion, Combustion of Oil, Coal, and Gas, Biomass. **Calculation of theoretical air quantity, Excess air and CO_2 in flu gas.**	08
02	**Steam Systems and ENCON opportunities** Properties of steam, Steam distribution losses, Steam leakages, **Steam Pipe Sizing** and Design, Selection, Operation, Maintenance & Testing of Steam Traps, Condensate and flash steam recovery, Energy conservation (ENCON) opportunities in steam systems	10
03	**Boilers and ENCON Opportunities** IBR boiler specifications, Fire tube, water tube, packaged, stoker fired boiler, Combustion in boilers, **Direct & Indirect Method to find boiler efficiency**, Blow down types &**performancecalculations**, Feed water treatment, ENCON opportunities, Case study,Fluidized bed combustion (FBC) boiler types and advantages	10
04	**Furnace and ENCON Opportunities** Types of furnace, Heat transfer, Losses in furnace, **Direct & Indirect Method to find Efficiency of furnace**, Excess air, Heat distribution, Temperature control, Draft control General fuel economy measures in furnaces, Case study	08
05	**Insulation and Refractories** Types of furnace, Heat transfer, Losses in furnace, **Direct & Indirect Efficiency**, Excess air, Heat distribution, Temperature control, Draft control General fuel economy measures in furnaces, Case study	10
06	**Cogeneration (CG) & Waste Heat Recovery (WHR)** Definition, need & principle of CG, technical options of CG, CG cycles, Selection of CG systems, Performance evaluation of CG, Case study , Need of WHR, Waste sources and Quality, Benefits of WHR.	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.**

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. Energy efficiency in thermal utilities, Book 2, Bureau of Energy Efficiency India.
2. Energy performance assessment for equipment & utility systems, Book 4, Bureau of Energy Efficiency India.
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 Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
6. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

Course Code	Course Name	Credits
ESMC103	**Conventional Power Plants**	**04**

Objectives

1. To conduct detailed analysis of power plant cycles.
2. To understand the advancement in conventional energy systems.
3. To conduct economic analysis of energy systems.

Outcomes: Learner will be able to…

1. Distinguish between energy & power and understand power plant cycles in detail.
2. Understand steam systems and steam power plant installation, operation, maintenance, and life cycle economics.
3. Understand power plant installation, operation, maintenance, and life cycle economics.
4. Learn the advantages and disadvantages of combined operation of power plants.

Module	Detailed Contents	Hrs.
01	**Introduction** Energy and Power, Principal types of power plants, Power plant cycles and their classification, Performance Evaluation of Power plant cycles.	09
02	**Steam Power Plants** Classification, Layout, Essential requirements of Power Station Design, Site Selection, Capacity, Plant arrangement, Useful life of SPP components, SPP pumps, Advantages and Disadvantages, Cost and Economics of SPP	10
03	**Gas Turbine Power Plants** General aspects, Advantages and Disadvantages of GTPP over SPP, Site selection, Classification of GTPP, GTPP fuels, Operation of GTPP, GTPP layout, Effect of operating variables on thermal efficiency, Combined GT and SPP	10
04	**Hydro-Electric Power Plants (HePP)** Advantages and disadvantages, Site selection, Essential features/elements of HePP, Classification, Plant layout, Average life of HePP components, Electrical and Mechanical components, Comparison of HePP and SPP, Underground HePP, Advanced HePP, Safety measures and preventive maintenance, Cost of HePP and hydroelectric power	08
05	**Nuclear Power Plants** General aspects, Nuclear power systems, Main components of NPP, Advantages of NPP, Site selection, Applications, Economics of NPP, Safety measures for NPP, Future of NPP, Nuclear Power Plants in India, Useful byproducts of Nuclear power generator and their uses	07
06	**Combined Operation of Plants** General aspects, Advantages of COP, Load division and power stations, Coordination of different power plants, Cost comparison and cost analysis of SPP, GTPP, HePP and NPP	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 Nonconventional/conventional Power 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. El-Walkil M M, Power Plant Engineering, McGraw Hill, New York, 1985
2. Power Plant Familiarization, Manual of Central Training Resources Unit of NTPC India, 1991
3. P K Nag, Power Plant Engineering, TMH, New Delhi, 1998
4. A K Raja, Amit Praksh Shrivastava, Manish Dwivedi, Power Plant Engineering, New Age International Publishers
5. M G Jog, Hydro-Electric and Pumped Storage Plants, New Age International Publishers

Course Code	Course Name	Credits
ESMDLO 1011	**Utilization of Solar Energy&#**	**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 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.

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 and J K Nayak, **Solar Energy - Principles of thermal collection and storage**, 3rd Ed Tata McGraw-Hill, New Delhi.
2. J. A. Duffie and W. A. Beckman, **Solar Engineering of Thermal Processes**, 2nd Ed, 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.
6. Soteris A. Kalogirou, **Solar Energy Engineering: Processes and Systems**, Academic Press, 2009

Course Code	Course Name	Credits
ESMDLO 1012	**Cogeneration and Waste Heat Recovery Systems#&**	**04**

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	10
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 systems working on waste heat	09
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	08
05	**Applications & Techno Economics of Waste Heat Recovery Systems:** Applications in industries, selection of waste heat recovery technologies - financial considerations, saving potentials of different waste heat sources - operations and investment costs of waste heat recovery	07
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.

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. Sengupta Subrata, 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
7. **BEE Reference Book No** 2 and 4, BEE India

Course Code	Course Name	Credits
ESMDLO 1013	**Alternative Fuels#&**	**04**

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 Biofuels** 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.

End Semester Theory Examination:

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

References:

1. 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
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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
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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
ESMDLO 1014	**Energy Systems Modeling and Analysis**	**04**

Objectives

1. To model and simulate the energy systems for performance improvement analysis.
2. To apply quantitative techniques for optimization of operating parameters in energy system.
3. To use economic techniques for energy model development.

Outcomes: Learner will be able to…

1. Understand model development process and its application in energy systems.
2. Apply quantitative technique in energy systems planning, operation and maintenance.
3. Simulate the conventional and sustainable energy systems.

Module	Detailed Contents	Hrs.
01	**Modeling overview** Levels of analysis, steps in model development, examples of models, Need for Energy System Modeling.	06
02	**Quantitative techniques** Interpolation-polynomial, Lagrangian, Curve fitting, regression analysis, solution of transcendental equations.	08
03	**Systems Simulation** Information flow diagram, solution of set of nonlinear algebraic equations, successive substitution, Newton Raphson. Examples of energy systems simulation. Numerical solution of Differential equations- Overview, Convergence, Accuracy. Transient analysis- application example	12
04	**Optimization** Objectives/constraints, problem formulation. Unconstrained problems- Necessary & Sufficiency conditions. Constrained Optimization- Lagrange multipliers, constrained variations, Kuhn-Tucker conditions, Linear Programming - Simplex tableau, pivoting, sensitivity analysis. Dynamic Programming. Search Techniques- Univariate / Multivariate	12
05	Case studies of optimization in Energy systems problems. Dealing with uncertainty- probabilistic techniques. Trade-offs between capital & energy using Pinch Analysis	08
06	Energy- Economy Models: Scenario Generation, Input Output Model	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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4. Only Four questions need to be solved.

References:

1. Yogesh Jaluria, Design and Optimization of Thermal Systems, McGraw-Hill international editions, 1998
2. Stoecker W F, Design of Thermal Systems, Mcgraw Hill, 1981
3. S.S.Rao, Optimisation Theory and Applications, Wiley Eastern, 1990
4. S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall, 1988
5. P. Meier, Energy Systems Analysis for Developing Countries, Springer Verlag, 1984
6. R.de Neufville, Applied Systems Analysis, Mcgraw Hill, International Edition, 1990
7. Beveridge and Schechter, Optimisation Theory and Practice, Mcgraw Hill, 1970

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:

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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:

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4. Only Four question need to be solved.

REFERENCES:

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

Course Code	Course Name	Credits
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

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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 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
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

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

Assessment:

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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:

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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:

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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:
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. 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
ESML101	**Energy System Modelling and Simulation Lab**	**01**

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

1. Study of Different Modeling Techniques practiced in Power Plant Engineering
2. Simulation study using Mathematical Simulation Software (or any programming language) on any two conventional power plants
3. Simulation study of any two non conventional power plant
4. Visit to Power Plant Control Room to Understand Automated Control System in Power Plant and prepare visit report.

Assessment:

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

Course Code	Course Name	Credits
ESML102	**Energy Audit Lab**	**01**

The following experiments are performed and readings must be entered in the energy audit report format.

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

Course Code	Course Name	Credits
ESMC201	**Advances in Energy Management & Audit**	**04**

Objectives

1. To collect and analyze the energy audit data effectively
2. To understand the mechanism of PAT cycle.
3. To become certified energy manager and auditor.

Outcomes: Learner will be able to…

1. Understand detailed energy auditing procedure and Distinguish between energy auditing stages.
2. Monitor and setting target of energy consumption.
3. Know the framework of PAT cycle and understand M&V audit
4. Carry out commercial energy audits.

Module	Detailed Contents	Hrs.
01	**Energy Management and Audit Methodology** Energy Audit and Management, Energy audit Inquiry Generation, Walk in Audit, Preliminary Energy audit, Detailed Energy Audit, Targeted Energy Audit, Financial feasibility and Economic Approach, Energy Audit Report Format, Case study.	06
02	**Categories of Energy Manager and Auditor** Energy Manager (EM), Energy Auditor (EA) certification in India, Duties and responsibilities of EM and EA, Accredited Energy Auditor (AEA), Empanelled AEA, BEE (The manner and intervals of time for conduct of energy audit) Regulations, 2008.	08
03	**Energy Monitoring and Targeting (EMT)** Definition of EMT, Elements of EMT system, Decision Making of EMT, Data information sources, Data analysis, Statistical representation of Energy consumption and Production, Least square method, Correlation & regression, CUSUM technique.	10
04	**Perform, Achieve & Trade (PAT) Cycle** Brief description of PAT (Perform, Achieve & Trade) Cycle, Designated Consumer, Institutional framework for PAT, Role of each entity in PAT cycle, Activities and Responsibilities for PAT cycle, EScerts Issuance flow chart, Trading of EScerts.	08
05	**Energy Audits in PAT cycle** Baseline Energy Audit, Definition of (Monitoring & Verification) M & V, Team formation for M&V audit, Appointment and Role of Empanelled AEA, Documents required for M & V, Gate to Gate Diagram for various industries, Verification process, Concept of Normalization in PAT, Need for Mandatory Energy Audit.	10
06	**Energy Audit in Commercial Sectors** Need of energy auditing in commercial sectors, energy audit in corporate buildings, educational institutes, Hospitals, Banks, Resorts, government buildings, Estimation of building load, steady state method, network method, numerical method, correlations, Calculation of energy saving potential by ENCON opportunities.	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. BEE Reference books: no.1/2/3/4
2. http://beenet.gov.in
3. PAT booklet, BEE India
4. Handbooks of Energy Audits and Management, edited by A. K Tyagi, TERI, India.
5. Abstract, Methodology for Monitoring & Verification of Specific Energy Consumption performance of Designated Consumers © Bureau of Energy Efficiency, Government of India, March 2015.
6. AmlanChakrabarti, Energy engineering and management, PHI Learning, New Delhi 2012
7. ShaligramPokharel, Energy Analysis for Planning and Policy, CRC Press, 2014

Course Code	Course Name	Credits
ESMC202	**Energy Efficiency in Electrical Systems**	**04**

Objectives

1. To learn electrical and power systems.
2. To understand working principle of electrically assisted systems.
3. To identify saving potential in electrically assisted systems.

Outcomes: Learner will be able to…

1. Calculate losses in electrical and power systems and improve its energy efficiency.
2. Determine ENCON opportunities in electrical motor systems.
3. Determine ENCON opportunities in fluids handling systems.
4. Determine ENCON opportunities in lighting systems.

Module	Detailed Contents	Hrs.
01	**Electrical and Power System** Electric power supply, Transmission and Distribution Losses, Electricity Billing, Electrical Load Management, Power Factor Improvement, Transformers, Harmonics, Analysis of Electrical Power Systems, Maximum demand controllers. Automatic power factor controllers, Energy efficient transformers, Case study.	08
02	**Electrical Motors** Types, Characteristics & Efficiency of Motors, Selection, Factors Affecting Energy Efficiency, Rewinding, Motor Load Survey Methodology, Energy efficient motors, Soft starters with energy saver, Variable speed drives, ENCON opportunities, Case study.	08
03	**Fans, Blowers and Compressors** Difference between Fans, Blowers and Compressors, types, Flow control methods in fan, **Fan performance evaluation**, Types of compressor, **Compressor Performance Evaluation**, Compressed Air Systems & their efficient operation, Compressor Capacity Assessment, ENCON opportunities, Case study.	12
04	**Refrigeration and HVAC system** Types of refrigeration system, components, Chilling plant, Selection and performance assessment of refrigeration plants, Factors affecting energy efficiency of refrigeration plants, ENCON opportunities, Case study.	08
05	**Centrifugal Pumps & Cooling Towers** Pump types, System & pump characteristics, **Pump Performance evaluation**, Energy efficient pumping system operation, ENCON opportunities by Flow control methods in pumps, Use & types of cooling tower, Performance evaluation, Energy efficient operation, Flow control methods, Case study.	10
06	**Lighting Systems** Terms in Lighting System, Lamp Types & features, Recommended luminance Levels, Lighting Design calculations for Interiors, Lighting System Energy Efficiency Study Methodology, Energy Efficient Replacement Options, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Case Study.	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:
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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. Energy efficiency in electrical utilities, Book 3, Bureau of Energy Efficiency India.
2. Energy performance assessment for equipment & utility systems, Book 4, Bureau of Energy Efficiency India
3. Electrical energy conservation modules of AIP-NPC, Chennai
4. PCRA Publications on Compressed Air System
5. Technology Menu for Energy Efficiency (NPC)
6. ASHRAE Hand Book
7. British Pump Manufacturers' Association Catalogue
8. Energy Management Supply & Conservation, Butterworth Heinemann, Dr. Clive Beggs.

Course Code	Course Name	Credits
ESMC203	**Renewable & Sustainable Energy Systems**	**04**

Objectives

1. To understand the concept of sustainable development.
2. To know the economics of renewable energy and financing options.
3. To determine role of renewable energy in upcoming projects.

Outcomes: Learner will be able to…

1. Know sustainability initiatives for reducing energy impacts on environment.
2. Understand the role of renewable energy in climate change.
3. Determine the efficient solar and wind energy technology.
4. Know the current trends in sustainable and renewable energy.

Module	Detailed Contents	Hrs.
01	**Sustainable Energy & Environment** Sustainable Development, Energy technologies promoting sustainability, Environmental impacts, Economic and social considerations, Financing mechanisms, Carbon credits, clean development mechanisms, Climate change, COP21.	08
02	**Renewable Energy** Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy.	08
03	**Solar Energy Technology** Solar thermal power plants (Concentrators, solar chimney etc.), Solar thermal conversion devices, Economics and social considerations, Design considerations of component selection, CSP (Concentrated Solar Power) advanced materials. Solar photovoltaic power plants, photovoltaic technology, Design of a photovoltaic system, economics and costing, Application as a distributed power supply strategy.	12
04	**Wind Power Technology** Wind energy potential measurement, wind mill component design, economics and demand side management, energy wheeling, and energy banking concepts.	07
05	**Biogas Energy** Aerobic and anaerobic bio-conversion processes, microbial reactions purification, properties of biogas. Storage and enrichment, Biogas energy economics.	07
06	**Current Trends in Renewable & Sustainable Energy** Fuel cell based power plants, tidal and wave energy plant design, OTEC power plants. Geothermal energy: hot springs and steam ejection site selection, Renewable energy Financing criteria, Net Metering, Solar cities, Role of energy in smart cities.	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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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. General Aspects of Energy Management and Energy Audit, Book 1, Bureau of Energy Efficiency India.
2. G. N. Tiwari and M. K. Ghosal, Renewable Energy Resources: Basic Principles and Applications, Alpha Science International Ltd., 2005.
3. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 3rd edition, 2006.
4. G. Boyle, Renewable Energy: Power for a Sustainable World, Oxford University Press, 2006.
5. T.C.Kandpal and H.P.Garg., Financial Evaluation of Renewable Energy Technologies, Macmillan India Ltd., 2003.
6. J. Twidell and T. Weir, Renewable Energy Resources, Taylor & Francis, 2007.
7. G. N. Tiwari, Solar Energy: Fundamentals, Design, Modelling and Applications, Narosa Publishing House, 2010.
8. Harry Campbell and Richard Broron, Benefit- Cost Analysis, Cambridge University Press, 2003.
9. Chan S. Park, Contemporary Engineering Economics, Prentice Hall Inc., 2002.
10. Gerald J. Thuesen and W.J. Fabrycky, Engineering Economy (ninth edition), Prentice Hall Inc., 2001.

Course Code	Course Name	Credits
ESMDLO 2021	**Energy Storage Systems**	**04**

Objectives

1. To understand the working principle of energy storage systems.
2. To identify and select the efficient energy storage systems.
3. To find suitable application of storage system.

Outcomes: Learner will be able to…

1. Distinguish between different modes of energy storage.
2. Know the working principle and selection of Energy Storage System.
3. Understand the concept of Sensible and Latent Heat Thermal Energy Storage.

Module	Detailed Contents	Hrs.
01	**Energy Storage** Need of energy storage; Different modes of Energy Storage. Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energy storage. Solar Ponds for energy storage	12
02	**Electrochemical Energy Storage Systems** Batteries: Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon Nano-tubes in electrodes.	08
03	**Magnetic and Electric Energy Storage Systems** Superconducting Magnet Energy Storage(SMES) systems; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor(EDLC), principle of working, structure, performance and application, role of activatedCarbon and carbon Nano-tube (CNT).	09
04	**Sensible Heat Storage** SHS mediums; Stratified storage systems; Rock-bed storage systems; Thermal storage in buildings; Earth storage; Energy storage in aquifers; Heat storage in SHS systems; Aquifers storage.	08
05	**Latent Heat Thermal Energy Storage** Phase Change Materials (PCMs); Selection criteria of PCMs; Stefan problem; Solar thermal LHTES systems; Energy conservation through LHTES systems; LHTES systems in refrigeration and air-conditioning systems; Enthalpy formulation; Numerical heat transfer in melting and freezing process.	09
06	**Application of Energy Storage** Food preservation; Waste heat recovery; Solar energy storage; Greenhouse heating; Power plant applications; Drying and heating for process industries.	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
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. Thermal Energy Storage Systems& Applications, Ibrahim Dincer, Mark Rosen, John Wiley& Sons 2002.
2. Electrochemical Technologies for energy storage & Conversions, Ru-shillu, Leizhang, Wiley Publications, 2012
3. Solar Thermal Energy Storage, H P Garg, S C Mulik, A K Bhargava, 1985.
4. Advances in Thermal Energy Storage Systems: Methods and Applications, Woodhead Publishing Series in energy
5. Solar Collectors, Energy Storage and Materials (Solar Heat Technologies), Francis de Winter, The MIT Press, 1991.

Course Code	Course Name	Credits
ESMDLO 2022	**Fuels Combustion and Emission Control**	**04**

Objectives

1. To give an idea about types of fuels, origin, reserves and their processing.
2. To define the combustion and conversion process of fuels.
3. To analyze the impact of incomplete combustion, emission on environment.

Outcomes: Learner will be able to…

1. Distinguish between conventional, non-conventional and nuclear fuels.
2. Understand the types and production process of fuels.
3. Determine the requirements for complete combustion process.
4. Analyse the effects of emission control

Module	Detailed Contents	Hrs.
01	**Introduction to Fuels** Types of fuels, commercial and non-commercial fuels, Principle fuels for energy conversion: Fossil fuels, Nuclear fuels, RDF, Bio-fuels	05
02	**Solid Fuels** Different types of solid fuels, Family of coal, origin of coal, composition of coal, analysis and properties of coal, action of heat on coal, oxidation of coal, hydrogenation of coal, classification of Indian coal, Storage of coal, carbonization, gasification and liquefaction and pulverization of solid fuels.	09
03	**Liquid Fuels** Introduction to Petroleum, origin of petroleum, petroleum production, composition and classification, processing of petroleum, Important petroleum products, properties of petroleum products, liquid fuels from sources other than petroleum, storage and handling of liquid fuels, gasification of liquid fuels, petroleum refining in India.	09
04	**Gaseous Fuels** Classification of gaseous fuels based on mode of occurrence and method of production, cleaning and purification of gaseous fuels. Hydrogen as energy carrier	08
05	**Combustion of Fuels** Combustion stoichiometry, Nature of combustion process, types of combustion process, Mechanism of combustion reaction, Spontaneous ignition temperature, velocity of flame propagation, limits of inflammability, flame structure, stability and diffusion of flames. Kinetics of liquid and solid fuel combustion. Combustion appliances: Oil and gas burners, coal burning equipment.	15
06	**Emission control** Introduction, atmosphere, Emission control methods. Quantification of emissions.	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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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. D P Mishra, Fundamentals of Combustion, PHI Publications.
2. S P Sharma, Fuels and combustion, Tata McGraw Hill Publications, 1984.
3. Samir Sarkar, Fuels and combustion, Universities Press (India) Pvt Ltd, Third Edition 2009.
4. Stephen Turns, an Introduction to Combustion: Concepts and Applications, McGraw Hill Publications.
5. K K Kuo, Principles of combustion 2nd Edition, John Wiley & Sons, New Jersey, 2005
6. Gupta R B, Boca Raton, Hydrogen fuel: Production, transport and storage, CRC Press, 2008
7. Combustion Engineering and Fuel Technology, Oxford & IBH Publishing Company A. K. Shaha.
8. S. Sarkar, Fuels and Combustion, Orient Longman, 2nd edition, 1990.
9. F. Peter, Fuels and Fuel Technology, A. Wheatan& Co. Ltd., 1st edition, 1965.

Course Code	Course Name	Credits
ESMDLO 2023	**Energy Measurement and Control Instruments**	**04**

Objectives

1. To identify and select the correct instruments for related parameters
2. To learn the operation of automatic control systems.
3. To train about the handling and maintenance of energy measurement instruments

Outcomes: Learner will be able to…

1. To understand the basic measurement concepts and principles.
2. To learn the methods of measuring the process parameters.
3. To understand techniques of measuring energy system parameters.
4. To learn selection of proper instrument for concerned measurement.

Module	Detailed Contents	Hrs.
01	**Measurement Concepts** Introduction to measurements for scientific and engineering application need and goal. Broad category of methods for measuring field and derived quantities. Principles of measurement, parameter estimation, regression analysis, correlations, error estimation and data presentation, analysis of data	10
02	**Process Parameter Measurement** Measurement of field quantities, measurement of force, pressure, temperature, flow rate, velocity, humidity, noise, vibration, measurement by probe and non-destructive techniques, Name, Make and Specification of Instruments.	09
03	Measurement of derived quantities, torque, power, thermo physical properties, radiation and surface properties, Name, Make and Specification of Instruments.	09
04	**Automatic Control Systems** Control Room Equipment, PLCs and other logic devices, Analytical instrumentation,	10
05	**Instrument Selection and Commissioning** General considerations, Control valve selection and sizing, Regulators and final control elements, Limits, Margins and their Relevance to Instrumentation and control, Control Centers, Fire and Safety Instruments	10
06	**Instruments in Energy Auditing** Need of measurement, electrical, mechanical, thermal, chemical, fluid measurement, types of instruments, handling of instruments on site and off site, care of instruments, calibration.	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. Bela G Liptak, Instrument Engineers' Handbook, Vol I, II, III, 4th Edition, CRC Press
2. Doebelin E.O: Measurement Systems-Application and Design, McGraw Hill Publication Co.
3. Bolton W, Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg.
4. Helfrick A.D. and Cooper W.D. Modern Electronic Instrumentation and Measurement Technique.
5. Johnson C.D., Process Control Instrumentation
6. J.P.Holman: Experimental Methods For Engineers, McGraw Hill International Edition, Seventh Edition
7. Bureau of energy efficiency book No 1.

Course Code	Course Name	Credits
ESMDLO2024	**Energy Systems & Environmental Impact**	**04**

Objectives

1. To understand impact of energy systems on environment.
2. To know the pollution control techniques.
3. To recite energy and environment policies.

Outcomes: Learner will be able to…

1. Determine the impact of pollutants on atmosphere.
2. Propose the pollution control systems in energy systems.
3. Understand International and Indian environment policies.
4. Calculate the effect of energy efficiency on global climate change.

Module	Detailed Contents	Hrs.
01	**Effect of Energy Systems on Environment** Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SOx, NOx, SPM in air, Depletion of ozone layer, global warming, Physiological and health problems due to energy plants. Methods of Environmental Impact Assessment.	08
02	**Water, Air and Land Pollution** Sources of Pollution in thermal power plant, Water, air, land pollution due to estimation for thermal power plant. Environmental pollution limits guidelines for thermal power plant pollution control, Water pollution in thermal power plant, physical and chemical methods of pollution control, Measurement and effects of land pollution, Pollution control systems. Hydrothermal plant environmental assessment, Nuclear power plants and environmental pollution, pollution control measures.	10
03	**Pollution due to Automobile & Utilities** Pollution due to automobile and utilities, Methods to Control emission from Vehicle, Boilers & Furnaces., International Standards for Quality of air and norms for exhaust gases. Software advantage & disadvantage in automobile pollution inspection.	08
04	**Energy Recovery from Industrial and Urban Waste** Industrial waste, Waste and effluent treatment plants, Industrial, domestic and solid waste as a source of energy, Water treatment plant in housing societies.	08
05	**Environmental and Pollution Control Policies** United Nations Framework Convention on Climate Change (UNFCC), IPCC, Conference of Parties (COP), COP 21 Accord, Clean Development Mechanism (CDM), Prototype Carbon Funds (PCF) Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project in India.	08
06	**Energy Efficiency and Global Climate Change** Global Environmental Issues, Acid rain, Loss of Biodiversity, Ozone layer depletion, Global Warming Potential (GWP), Global worming & Climate change Impact, India's Green House Gases Emission.	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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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. Management of Energy Environment Systems W.K.Foell (John Wiley and Sons).
2. Energy Management and Control Systems M.C.Macedo Jr. (John Wiley and Sons)
3. Environmental Impact Analysis Handbook J.G.Rau, D.C.Wood (McGraw Hill)
4. Energy & Environment – J.M. Fowler, (McGrawHill)
5. Thermal Environmental Engineering, J.L. Threlkeld, Prentice Hall, 1970.
6. BEE Reference book: no.1
7. Global Warming: J Houghton, Cambridge University Press, New York, 1997.
8. CDM Country Guide for INDIA: Institute for Global Environmental Strategies (Ed), Ministry of the Environment, Japan, 2005.
9. Global Environmental Issues: F Harris (Ed), John Wiley, Chichester 2004.
10. http://beeindia.gov.in

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:

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. 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:

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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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:

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
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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.	5

	• Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	
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:

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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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:

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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
ESML201	**Renewable Energy Lab**	**01**

The laboratory will focus on the following,

1. Measurement of solar radiation and sunshine hours
2. Measurement of albedo, UV & IR radiation
3. Measurement of emissivity, reflectivity, transmittivity
4. Performance testing of solar flat plate water heater (forced flow & thermosyphon systems)
5. Performance testing solar air heater & dryer & desalination unit
6. Performance testing of solar thermal concentrators
7. Characteristics of photovoltaic devices & testing of solar PV operated pump
8. Testing of Gasifier or Wind machines or Fuel cell

Assessment:

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

Course Code	Course Name	Credits
ESML202	**Measurement & Virtual Instrumentation Lab**	**01**

Topic

I. Study of sensor characteristics, selection, calibration and measurement of minimum 05 mechanical parameters such as flow, load, pressure, speed and temperature

II. Virtual Instrumentation (VI)

a. Simulation of any system with Virtual Instrumentation environment using any suitable software

b. Interfacing of sensors used for measuring above mentioned parameters in I with VI software and measurement of these parameters on any laboratory model or actual working system

III. Demonstration of interfacing of VI software with suitable generic hardware

Assessment:

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

Course Code	Course Name	Credits
ESMS301	**Seminar**	**03**

Guidelines for Seminar

- Seminar should be based on thrust areas in Mechanical Engineering (Energy Systems and Management 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

Course Code	Course Name	Credits
ESMD301/ ESMD401	**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/Journal (desirably in Refereed Journal).

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