NATIONAL PRODUCTIVITY COUNCIL

Syllabus
&
Details about CETEE (Lab) Facility

Industry Oriented One Year Post Graduate Certificate Programme

in

ENERGY MANAGEMENT
(2019 – 2020)

NATIONAL PRODUCTIVITY COUNCIL

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(Under Ministry of Commerce & Industry, Govt. of India)
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SYLLABUS

REFRESHER MODULES

1. Heat Transfer

Introduction, heat transfer processes, thermo physical properties, formulation of heat transfer problem, dimensional analysis, engineering heat-transfer-conduction, convection and radiation; application-fin design, heat exchangers, numerical methods and digital computer solutions.

2. Fluid Mechanics

Basic concepts and conservation laws: Momentum of fluids in motion and theories, model studies-dimensional analysis similitude- geometric, kinetic and dynamic similarity; concepts of boundary layer, energy loss due to friction, sources of other losses, equivalent length techniques, mach number, adiabatic flow of gases in nozzles; flow of non-**N**ewtonian fluids; fluid flow problems in the operation of ratio-dynamic machines.

3. Thermodynamics

Definitions, concepts; Zeroth law of thermodynamics work, work transfer; first law of thermodynamics; first law analysis of stationery system; first law analysis of steady flow; second law of thermodynamics; entropy energy; general thermodynamic relations; thermodynamic properties of liquids, vapours and real gasses; non-reactive mixtures. Reactive System-combustion; homogeneous equilibrium; power and refrigeration cycles.

4. Electrical Engineering (Fundamentals)

Ohm's law and Kirchoff's laws, alternating currents, vector treatments, circuit relationship, power watt-meters and energy-meters, load-factor, power factor and their improvements.

FOUNDATION MODULES

1. Productivity and Economics

Concept and philosophy of productivity and standard of living. Productivity measurement and productivity techniques; sharing the gains of productivity, Micro-economics, Macro-economics; Theories of production and distribution; planning growth and economic development; econometric models.

2. Facility Planning and Design

Plant location; types of layout; evaluation of different layout; theory of safety; electrical, physical, chemical hazards; safety device and guards; principles of storage horizontal and

vertical space; principles of material handling; selection of material handling equipment; integrated plant layout and materials handling systems.

3. EDP, Systems Analysis and Design

Introduction to data processing; computer hardware and software; programming languages; VB, C, etc. exercises on flow charts and simple programmes; system analysis and design, document flow charts; SWOT analysis, input/output design; Data flow diagram and exercises; development of computer oriented maintenance systems (COMS)

- Client / Server Technology
- Internet, Intranet, E-commerce

4. Training Techniques & Communication

Determination of training needs; designing and administering training programmes, training methods, training aids; evaluation of training programmes; principles of learning and motivating the learner; programmed instructions and development of lessons, computer interactive learning.

5. General Management and Behavioural Science

Theories and principles of organization, its objectives and structure, transactional analysis, principles of management delegation and accountability, communication and leadership, work planning and time management, team building, discipline and grievance handling, morale and motivation.

6. Personnel Management

Human resources management and planning, selection placement, induction and training, personnel function, policies and procedures, factories Act & ID Act, management by objectives, personnel records, counseling and participative management, IR & Trade Union Act, personal appraisal and merit rating, organization analysis and development**.**

7. Financial Management, Cost & Budgetary Control

Principles of accountancy, classification of accounts and records; debit and credit; trial balance; balance sheet; Profit & Loss A/c. financial ratios and analysis.
Elements of manufacturing cost; standard costing; overhead distribution; budgeting for control of costs and revenues.
Equivalence and interest formulae; application of annual cost and present worth method; break-even analysis and applications: DCF and rate of return studies.

8. Methodology of Consultancy & Report Writing

Objective and scope, initial contact, preliminary, diagnostic and sectorial surveys, code of ethics, implementation linkages and report presentation. Purpose of reports: types of reports, preparation of reports, characterization of good reports, checklists for report writing, presentation of reports to top management and others.

9. Project Management

Goal Oriented Project Planning

Project management phases, drawing of network, time estimates and basic computations, crashing, resource leveling, update, revise and review.

10. Operations Research

Introduction to OR and model building; linear programming; allocation models; sequencing models; replacement models; queuing models; case exercises on models; dynamic programming**.**

11. Role of Energy in Manufacturing Operation

Energy input in process and engineering industry; batch and continuous process; energy intensive processes and products; energy, capital and labour; energy efficiency analysis in common manufacturing operation – forging, foundry, inorganic chemicals, food, diary, pulp and paper etc.

12. Fuels

Fossils fuels-solid, liquid and gaseous; processing of fuels; calorimeter of fuels, methods of analysis; fuel storage, handling and preparation.

13. Combustion Technology

Chemical bonds, bond energy, standard heats of formation, heats of reaction, Adiabatic flame temperature and composition of gases.
Chemical kinetics, rate laws, types of chemical reactions, conservation of mass, momentum and energy in reacting mixtures.

Heterogeneous chemical reactions, theories of explosion, reaction at solid surfaces. Flames-laminar and turbulent, diffusion flame length, tube dimension and flow rate.

Unconfined diffusion flames. Heterogeneous diffusion flames, combustion of single droplet of fuel, spray combustion. Principles of combustion, combustion calculation; fuel firing systems oil burners, chain and traveling grate, spreader stoker, excess air control, draft measurement and control, chimney height.

APPLICATION MODULES – PART-I

1. Boilers Systems

Steam boilers, basic types; design consideration; heat balance, Fuels and boiler types; boiler maintenance and operation; load distribution, components design, Auxiliary equipment-Design and sizing, Emission aspects, Efficiency Estimation (Direct & Indirect)– Sankey Diagram.

2. Steam Systems

Thermodynamic properties of steam, steam for process and power generation, efficient distribution of steam, efficient use of steam, steam trapping and air venting; operation, maintenance, selection and installation of steam types; condensate and flash steam recovery systems; vacuum systems.

3. Industrial Water Treatment

Raw. Industrial boiler feed water composition and analysis; interpretation of water analysis; specification of boiler water and feed water. Feed water treatment-chemicals, clarification, cold and hot process softeners, ion exchangers, demineralizers; theory of degasification, mechanical decorators, chemical decorators, cooling water treatment.

4. Industrial Furnaces, Refractoriness and Insulation

Furnaces, classification, heat transfer principles applicable to industrial furnaces, kilns and ovens; physical laws governing movement of gases; furnace atmospheres – importance, effect and its control; flues and stocks; circulation of gases; furnace construction-strength of roofs, hearths, etc.; design considerations for batch and continuous types of furnaces; melting, reheating furnaces; kilns and ovens; electric-furnaces; general fuel economy measure in furnaces. Types, properties of refractories and insulating materials, for low and high temperature application; selection and application; economic thickness of insulation; installation methods; application; economic thickness of insulation, installation methods.

5. Waste Heat Recovery

Definition, sources of waste heat; determination of waste heat; waste heat recovery devices-design and selection; low temperature waste heat recovery – ORC, heat pipes, energy wheels, absorption systems; economics of WHR and case studies.

6. Electrical Energy End Use

a) Motors and Variable Speed Drives (VSD)

Types of motors, losses in induction motor, motor efficiency and energy consumption, motor size and energy consumption, factors influencing induction motor characteristics, different types of drive systems, group drive vs individual drive, soft starting types and comparison of VSDs, speed control with ACV SD, energy saving potential and pit-falls.

b) Transformer

Principles of operations**,** powerfactor efficiency and regulation of transformer, types of insulation, load and no-load losses, satisfactory operation of transformer.

c) Fans, Pumps and Compressors

Properties of air; air flow in pipes, compressed air, fans and blowers-characteristic and laws; testing and performance, selection and application of fans, compressors – types and application, performance, design characteristics, installation, and operation. Compressor accessories governing and control pumps – selection and energy saving options.

d) Lighting

Industrial, domestic and street lighting, flood lighting, luminaries, energy efficient lighting schemes, control over décor, maintenance.

e) Air-conditioning and Refrigeration

Refrigeration cycles, refrigerants and properties, refrigeration compressors, steam ejector vacuum refrigeration system; absorption refrigeration. Refrigeration accessories; Brine circulate systems; heat pumps; comparison and selection of refrigeration systems. Conditioned air for industry and building; design of systems, humidification, humidity control; comfort cooling; air conditioning calculations; central air conditioning; industrial ventilation. Thermal storage, options, cooling towers design considerations and operation.

f) Heating and Melting Furnaces

Types of electrical furnaces, components of direct arc furnace, factors influencingenergy consumption in arc furnace, over view of induction furnace, design andoperational parameters affecting energy efficiency, crucible design, cordless induction furnace.

g) Electrolysis

Principles of electrolysis, electrolysis for production of gases and metal, construction of cathode/anode and diaphragm cell, effect of composition of bath, voltage, pressure, circulation flow rate, etc. on energy**.**

7. Instrumentation & Control Systems

Qualities of measurement; measurement of pressure, vacuum, flow and level. Temperature measurement-expansion thermometers thermoelectric temperature measurement, resistance thermometers, radiation temperature measurement. Flue gas measurement–CO2, O2 and CO measurement, maintenance of instruments.

Introduction to types of control; concept of feed-back control; proportionate integral and derivative control; control of process variable (pressure temperature, flow, PH conductivity, level, etc.) Distributed control.

APPLICATION MODULES – PART II

1. Thermal Power System Generation, Transmission and Distribution

Introduction to electrical energy systems. Pulverised fuel preparation, power boilers and design consideration, integrated operation of boilers and turbines, condensers and generators.

Generation: Synchronous generator operation, excitation and governing systems. Synchronisation, parallel operation, load sharing, efficiency, temperature rise and cooling. Auxiliaries in power station. Transmission: overhead lines and cables, Insulators. Transmission line equation. Single line diagram and per unit system. Distribution, economic operation; co-ordination of incremental production cost and transmission losses. Hydrothermal co-ordination.

2. Heat Engines

Power cycles and analysis, diesel and I.C. combustion and combustion chambers for I.C. engine; cooling and lubrication of I.C. engines; super charging; performance tests and characteristics of I.C. engines; diesel engines in road transport and power generating areas; comparison of various I.C. engines, heat recovery.

3. Turbine Cycles and Total Energy Co-generation

Cycle analysis and heat rate evaluation: factors affecting efficiency of power cycles; analysis of reheat and regenerative cycle; gas turbine cycles and performance; analysis of back pressure, mixed pressure and pass-out cycles, total energy systems – concepts and general consideration; industrial and commercial total energy system; combined cycles; economics of total energy systems.

4. Maintenance Management and Engineering

Basic concepts of maintenance; maintenance system and control; predictive maintenance, tero-technology, signature analysis, vibration analysis; tribology; theories of corrosion and

corrosion control, corrosion problems in power plants, overhauling of boilers, on-load maintenance, chemical cleaning.

5. Energy Environment Interface

Need for balanced ecology, effluents, particulate matter, pollution from process and power plants, prevention measures, control devices. Design of wastewater treatment plant, design concepts of cyclones, ESPs, venturi scrubbers.

6. Energy Audit, Monitoring and Targeting

Introduction to energy audit, preliminary and detailed energy audit and their conduct, instruments for preliminary and detailed energy audit, case studies, different types of monitoring systems, approach to monitoring and targeting data collection, analysis and reporting.

7. Energy Conservation in Unit Operations

Drying, evaporation, distillation and grinding operations selection design considerations, operation, retrofitting to reduce energy.

8. Energy Utilization in Energy – Intensive Industries

Consumption of energy in different operations and their improvements in iron and steel fertilizers, refineries and petro-chemicals, pulp and paper, textile, cement aluminum, glass, ceramics and foundries.

9. Energy Efficient Buildings

Introduction to Energy Efficient Buildings, Landscape and building Envelopes, Heating, Ventilation and Air-Conditioning, Heat transmission in buildings, Passive cooling &Renewable energy in buildings

10. Computer Application in Energy Management

Introduction to computers, programming languages micro-processors – introduction, programming design, typical application in energy related areas – Computer Organization – Information Technology - Data Base Management Systems – Energy Data Base – Net Working – time sharing concepts – Software engineering – simulation modeling – computer graphics – computer aided design – computer based monitoring and on—line control systems – Data acquisition systems, Expert bases systems for energy management, parallel processing concepts.

ADVANCED MODULES

1. Renewable / new energy sources and their applications

Bio-gas plant technology and status – solar energy – principle, scope, design and applications – geothermal energy – hot springs, steam ejection, site selection, power plants, advanced concepts – fusion – nuclear reactors, fuels, ignition systems, confinement schemes, current status – fuel cells – principle, scope, application – OTEC – principle, scope and application..

2. Energy Economics

National Overview, economics of exhaustible resources, models of oil prices, reserves and cost estimation; theory of Government of subsidies; energy production models; energy demand-factors influencing; energy conservation economics.

3. Direct Energy Conversion

Survey of energy conversion problem, basic science of energy conversion. Physics of semiconductor junction for photovoltaic and petrochemical conversion of solar energy, fabrication and evaluation of solar cells. Applications of solar cells in photovoltaic power generation systems. Technology and physics of thermo electric generators. Thermo electric materials and optimisation studies. Basic concepts and design considerations of MHD generators. Cycle analysis of MHD systems. Thermion power conversion and plasma. Thermodynamics and performance of fuel cells and their applications.

4. Bio-conversion and Processing of Waste

Bio-conversion mechanism, source of waste undergoing industrial photo-synthesis. Energetics and rate process of major biological significance, bio-conversion of substrate into alcohol. Bio-fertilizer from waste-operating parameters and design of various units. Analysis of fermentation and biological pathways. Biogas from various substrate. Design of various biogas plant. Aeration and agitation, scale of concepts. Sterilization and harvesting unicellular growth kinetic and mixed cultunet dynamics biological treatment of various industrial wastes and their utilization for energy needs, growth, harvesting, processing and utilization of algae and water hyacinth.

5. Energy Technology

Over-view of existing technologies – coal technology, coat conversation purification processes – gas technology – handling, gasification processes – petroleum technology, transportation, petroleum processing – chemical fuels technologies – nuclear energy technologies – solar energy technologies – power technology – conversion systems, steam – combination, gas diesel and other, electric power transmission, measurement utilization technologies – effluent systems, emission monitoring systems – process technologies – other energy technologies.

6. Energy Efficiency and Smart Grid Strategies for a Sustainable Future

Building technologies -Systems, Analytics and controls, Emerging Technologies- IoT application in Energy Management, Energy/grid economics and policy, Strategies-management finance and marketing innovations

7. Energy Monitoring and Targeting

Defining monitoring and targeting, Elements of monitoring and targeting, Data and information analysis, Techniques-energy consumption and production, Cumulative sum of differences (CUSUM)

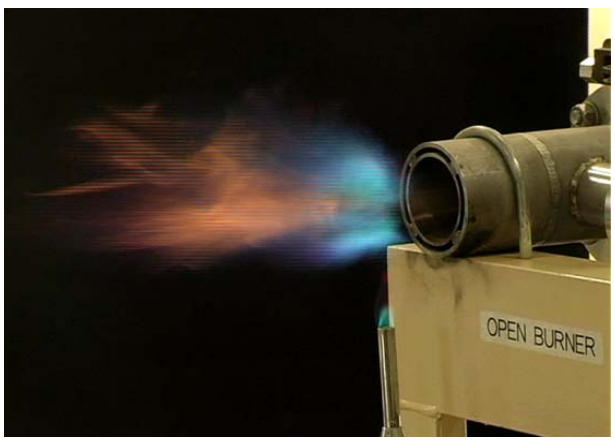
Practical Oriented Training (Laboratory sessions)

Energy efficiency in Electric Motors, Energy efficiency in lighting systems, Pumps and Pumping system, Fans, Blowers, Compressed air systems, Boilers and steam systems- Open burner &Furnaces, Heat exchangers and Cooling Towers.

CETEE (Lab) Facility

Heat Exchanger Lab

Open Burner& Furnace Lab



Boiler & Steam Traps Lab

Compressed Air System Lab

Blower Lab

Pumps and Pumping System Lab

Indoor Lighting Lab

Electric Motors Lab

Renewable Energy Systems

Training Halls