| B.E. VI SEMESTER MECHANICAL ENGINEERING | | | | | | | |
|---|---|---|---|---|---|---|---|
| COURSE CONTENTS (AICTE FLEXIBLE CURRICULA) | | | | | | | |
| **ME- 6301** | **I.C. Engine** | **L** | **T** | **P** | **C** | **Max. Marks** | **Min. Marks** |
| Duration | 3 Hours | 4 | - | 2 | 5 | 70 | 22 |

**Unit I**

Classification of I.C. engine, component and nomenclature, air standard cycles, Otto cycle, diesel and dual cycles, fuel air cycle and actual cycle, difference between air standard cycle, fuel air cycle and actual cycle, mean effective pressure, efficiency of the cycles. working principle of four stroke cycle engine (S.I. and C.I.) valve timing diagram for four stroke engine, port timing diagram of two stroke engine (S.I. and C.I.).

**Unit II**

**Combustion in S.I. and C.I. engines:** Homogeneous and heterogeneous mixture, combustion in S.I.engine, stages of combustion in S.I. engine, flame front propagation, factors influencing the flame speed. abnormal combustion, the phenomenon of knock in S.I. engine, effect of engine variables on knock combustion chambers in S.I. engines, combustion in C.I. engines, stages of combustion in C.I. engine, factor affecting the delay period, phenomenon of knock in C.I. engine, combustion chambers for C.I. engine.

**Unit III**

**I.C. Engine systems:** Ignition systems, cooling systems, lubrication systems, carburetion, theory of carburetion, simple problem of carburetion, fuel injection system of C.I. engine, MPFI, CRDI.

**Unit IV**

**Measurement, testing and performance:** Measurement of friction power, indicated power, brake power,fuel consumption, air consumption, exhaust and cooling temperature, emission, visible emission, noise, engine performance characteristics, variables affecting the performance characteristics, heat balance analysis.

**Unit V**

Supercharging, types of superchargers, methods of supercharging, effect of supercharging, limitation of supercharging, engine emission and control, alternate fuel for I.C. engines, turbo charging effect, methods and its limitations, environmental pollution, means of checking pollution, use of catalytic converter, international and Indian norms related to pollution control.

**Recommended Books:**


1. Course in I.C. engines by M.L. Mathur and R.P. Sharma;DhanpatRai Publications
2. Internal Combustion Engines by V. Ganeshan; McGraw-Hill Educations
3. Internal Combustion Engines Theory and Practice by G.F. Taylor; MIT Press
4. Introduction to I.C. Engines by Richard Stone;Sae Intl
5. Internal Combustion Engines by Domkundwar;DhanpatRai publications.

**Suggested list of experiments:**

1. Study of I.C. Engine parts and materials.
2. To demonstrate the cut section model of actual single cylinder two stroke petrol engine and diesel engine.
3. To demonstrate the cut section model of actual single cylinder four stroke petrol engine and diesel engine.
4. Study of carburetor and modification.
5. Study of fuel Injection system.
6. Study of ignition system.
7. To conduct a load test on a 4-stroke, single cylinder diesel engine, to study its performance under various loads.
8. To conduct a heat balance test on a 4-stroke single cylinder vertical diesel engine at different loads and to draw up a heat balance sheet on minute basis.
9. To conduct a heat balance test on a four stroke multi cylinder petrol engine at different loads and to draw up a heat balance sheet on minute basis.
10. To conduct Morse test on a 4-stroke, multi cylinder (4-cylinder) petrol engine to establish friction power, mechanical efficiency.
11. To conduct heat balance sheet on single cylinder 4-stroke petrol engine test rig.

**Course Outcomes (CO's)**

After completion of this course the student should be able to:

| CO | Statement |
|---|---|
| CO1 | Explain basic working principles and study various operating cycles of I.C engine. |
| CO2 | Understand and analyze the combustion processes in S.I and C.I engine. |
| CO3 | Compare various systems used in smooth operations of I.C engine. |
| CO4 | Compare various measurements and testing technique of I.C engine. |
| CO5 | Evaluate the concepts of better combustions and thus reducing emissions. |

**Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's):**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | - | - | - | - | - | 2 | - | - | 2 | 3 | - |
| CO2 | 3 | 2 | 2 | 2 | - | 1 | 1 | - | - | - | - | 1 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 2 | - | 2 | - | - | 2 | - | - | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | 2 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 2 | - | 3 | 3 | - | - | - | - | 3 | 3 | 3 |
| 1-Low, 2-Moderate, 3-High | | | | | | | | | | | | | | |

| B.E. VI SEMESTERMECHANICAL ENGINEERING | | | | | | | |
|---|---|---|---|---|---|---|---|
| COURSE CONTENTS (AICTE FLEXIBLE CURRICULA) | | | | | | | |
| **ME-6302** | **Machine Design - II** | **L** | **T** | **P** | **C** | **Max. Marks** | **Min. Marks** |
| Duration | 3 Hours | 3 | - | 2 | 4 | 70 | 22 |

**Unit I**

**Bearings and Lubrication:** Lubrications: Hydrodynamic, hydrostatic and boundary lubrications, types of lubricants and their properties; viscosity and temperature considerations.

Classification of bearings, factors affecting choice of bearings, bearing materials, bearingmodulus, Sommerfeld's number, design of journal bearings.

Antifriction Bearings: types, life and load ratings, reliability, selection of ball and roller bearings, bearing failure modes, lubrication of roller bearings.

**Unit II**

**Gear Design:** Design consideration for gear drive, gear materials, tooth load on spur gear, beam strength of gear tooth-Lewis equation, dynamic load, wear load, causes of gear tooth failure, complete design of spur gear, helical gear, bevel gear and worm gear drives.

**Unit III**

**Design of I.C. Engine parts:** General design considerations in I.C. engines, design of cylinder, design of piston, piston-troubles, design of connecting rod, design of crankshaft.

**Unit IV**

**Power Transmission:** Belt, rope and chain drives: power transmission mode, selection of flat belt and pulley design, selection of V belts and sheave design, design of chain drives, roller chain and its selection, rope drives, rope drive design, hoist rope.

**Unit V**

**Computer Aided Design and Optimization**

**Optimization:** Basic concept of optimization, classification of optimization, optimization techniques, engineering applications of optimization. Classical optimization techniques: unconstrained optimization, single variable optimization, multivariable optimization, solution by direct search method, solution by Lagrange multipliers method.

**Computer Aided Design Exercises:** Computer aided design of gears and bearings.

**Books Recommended:**


1. Mechanical Engineering Design by Shigley's; McGraw Hill.
2. Machine Design: An Integrated Approach, Norton L. Robert; Pearson education.
3. Design of Machine elements by V.B. Bhandari; Tata McGraw Hill.
4. Design of Machine elements by M.F. Spotts; Pearson Education.
5. Machine Design by Sharma and Agrawal; S.K. Kataria and sons.
6. Machine Design Data Book; PSG.

**During practice session students will solve:**

1. Problems related to design of hydrodynamic bearings for given operating conditions.
2. Problems related to selection of various types of rolling contact bearing for given operating conditions.
3. Problems related to design of spur gear, helical gear, bevel gear and worm gear.
4. Problems related to design of I.C engine cylinder, piston, connecting rod, and crankshaft.
5. Problems related to design of rope drives, belt drives, and chain drives.
6. Different engineering problems using various optimization techniques.
7. Design of gears and bearings using design software.

**Course Outcomes (CO's)**

After completion of this course the student should be able to:

| CO | Statement |
|---|---|
| CO1 | Assess role of Lubrication and Design/Select bearings under different operating conditions. |
| CO2 | Design gears used in the industries and understand failure modes in gears. |
| CO3 | Design and analyze I.C. engine parts. |
| CO4 | Design, Select and Analyze different power transmission systems. |
| CO5 | Apply mathematical techniques to optimize engineering design problems and design gears and bearings using design software. |

**Mapping of Course Outcomes (CO's) with Program Outcomes (PO's) and Program Specific Outcomes (PSO's)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 2 | - | 1 | 1 | - | 1 | - | 1 | 1 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 1 | 1 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 2 | - | - | - | 2 | - | 2 | 1 | 2 | 3 |
| 1-Low, 2-Moderate, 3-High | | | | | | | | | | | | | | |

| B.E. VI SEMESTER MECHANICAL ENGINEERING | | | | | | | |
|---|---|---|---|---|---|---|---|
| COURSE CONTENTS (AICTE FLEXIBLE CURRICULA) | | | | | | | |
| **ME- 6303** | **Production and Operation Management** | **L** | **T** | **P** | **C** | **Max. Marks** | **Min. Marks** |
| Duration | 3 Hours | 3 | - | 2 | 4 | 70 | 22 |

**Unit I**

**Operations Management (OM):** Definition, history, industrial and IT revolution; tangible and service products continuum, customer orientation; basic process formats on product volume-graph; concept of raw process time, critical WIP, bottleneck throughput and cycle-time, Little's law, best and worst case performance, throughput and cycle-time formula in practical-worst-case; criteria of performance, decision area, business strategy, environmental scan, SWOT, Porter' five forces, core competency, competitive priorities of cost, quality, time and flexibility, order winners; production strategy of Make to Order (MTO), Make to Stock (MTS) and Assemble to Order (ATO); productivity, standard of living and happiness.

**Unit II**

Product Life cycle and PLC management; design steps, evolution and innovation, traditional v/s concurrent design, form and functional design, simplification and standardization, differentiation / mass customization, modular design, design for manufacturing and environment (DFM,DFE), technologies used in design, service characteristics and classification based on people-things v/s direct-indirect service actions, triangle of customer, provider and system; technical and functional (delivery) service quality and other service performance factors, Valerie's service quality model; globalization of services.

**Unit III**

Processes transformation and value addition, selection based on cost, quality and flexibility considerations; process planning, designing of processes, steps in process planning, factors affecting process planning, process selection, flexible manufacturing system, automation, material handling equipments, automated storage, computer aided process planning, advantages and limitations, basic architecture, DSS, sustainable production processes.

**Unit IV**

**Plant-facilities :** Impact of organization strategies on choice of region and site, existing or new organization, decision-affecting factors for location, load distance, dimensional and factor analysis methods, Brown-Gibson model, foreign locations, non-profit govt. services (health, school) locations, facility layout objectives and factors, basic layouts, merits and optimization; subjective relationship ranking method, computer programs CRAFT and 3D modeling; problems of inventories flow and operators in process layout and inflexibility in product layout, flexible cellular layout, group technology; capacity and equipment selection, importance of spare capacity to reduce Q-length and cycle time.

**Unit V**

**Programs / Procedures of Production Control (PPC):** Corporate and production planning process, aggregate plan, master production schedule and material planning; matching supply to demand fluctuations over time horizon, Forecasting elements, time series, regression, causal and Delphi methods; use of LP in aggregate plan and HMMS model, assembly line balancing, elemental task, station time and cycle time, balance delays; sequencing, Johnson's method for n-job 2/3 m/c

**Recommended Books:**


1. Operations Management by Jay Heizer and Barry Render; Pearson Education.
2. Production and Operation Management by S.N. Chary; Tata McGraw Hill.
3. Factory Physics by W. Hopp and M. Spearman; Tata McGraw Hill.
4. Quality Management by Gitlow Howard et al; Tata McGraw Hill.
5. Production and Operation Management by R.B. Khanna, Prentice Hall.
6. Operation Management by Mahadevan; Pearson Education.
7. Operations Management by Chase Richard B et al; SIE-Tata McGraw Hill.


**Suggested list of experiments:**

1. To study about production management.
2. To study about human resource management.
3. To study and compare different production strategies.
4. To solve problems related to assembly line balancing.
5. To perform SWOT analysis of any project or business.
6. To study design for manufacturing and environment.
7. To study and compare different plant layouts.
8. To solve problem related to Brown-Gibson model.
9. To solve problems related to forecasting.
10. To solve problems related to sequencing.

**Course Outcomes (CO's)**

After completion of this course the student should be able to:

| CO | Statement |
|---|---|
| CO1 | Introductory knowledge of operations management which includes conceptual understanding of various organizational inputs covering both service providing and goods manufacturing organizations. |
| CO2 | Understand product life cycle and new product development procedures and applications. |
| CO3 | Apply various locational and layout planning tools for facility location decision. |
| CO4 | Analyze various production systems using production planning and control tools and technique. |
| CO5 | Sensitize about the world class practices in operations like JIT, ERP etc. |

**Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's):**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 3 | 1 | - | - | 2 | - | - | 2 | - | 3 | 2 | - | 2 |
| CO2 | 1 | 2 | 3 | 1 | - | 2 | 3 | 1 | 1 | 2 | 3 | 1 | 2 | 3 |
| CO3 | 1 | 3 | 1 | 3 | 2 | 2 | 2 | 1 | - | - | 3 | 2 | - | 2 |
| CO4 | 1 | 3 | 2 | 1 | 3 | - | 2 | - | 1 | 2 | 3 | 2 | - | 3 |
| CO5 | 1 | 3 | 3 | 2 | 3 | - | 2 | 1 | 2 | 1 | 3 | 1 | - | 3 |
| 1-Low, 2-Moderate, 3-High | | | | | | | | | | | | | | |

| B.E. VI SEMESTER MECHANICAL ENGINEERING | | | | | | | |
|---|---|---|---|---|---|---|---|
| COURSE CONTENTS (AICTE FLEXIBLE CURRICULA) | | | | | | | |
| **ME-6321** | **Turbo Machinery** | **L** | **T** | **P** | **C** | **Max. Marks** | **Min. Marks** |
| Duration | 3 Hours | 3 | 1 | 2 | 5 | 70 | 22 |

**Unit I**

**Energy Transfer in Turbo Machines:** Application of first and second law of thermodynamics in turbomachines, classification of turbo machines, concept of fluid dynamics, energy transfer in turbo machines, Euler's turbine and pump equation, forces on the rotor blades, components of the energy transfer (one dimensional analysis), comparison between Euler, Isentropic and Adiabatic work in turbo machines, principles of impulse and reaction machines, degree of reaction.

**Unit II**

**Steam Turbines:** Principle of steam turbine and its classification, impulse staging: simple impulse turbine,compounding of impulse turbine and its types, velocity diagrams, effect of blade friction on velocity diagram, forces on the blades and work done by the blades, diagram efficiency, gross stage efficiency, effect of blade and nozzle losses on blade efficiency, stage efficiency, analysis for optimum efficiency based on blade-velocity ratio, choice of blade angles, mass flow and blade height impulse-reaction staging: velocity diagram and work done, parson's turbine and its degree of reaction, gross stage efficiency, optimum value of blade-velocity ratio, blade efficiency and condition for optimum efficiency, state point locus: stage efficiency, reheat factor, internal efficiency, isentropic efficiency, mechanical efficiency energy losses, governing and performance characteristics of steam turbines.

**Unit III**

**Water Turbines:** Water turbines: heads andefficiencies, classification, Pelton, Francis and Kaplan turbines, vector diagrams and work-done, draft tube theory, governing of water turbines,performance characteristics curves of hydraulic turbines.

**Centrifugal Pumps:** introduction, advantage over reciprocating type, working of centrifugal pump, heads and efficiencies, vector diagram and work done performance and characteristics: application of dimensional analysis and similarity to water turbines and centrifugal pumps, unit and specific quantities, selection of machines, performance characteristics curves of centrifugalpump.

**Unit IV**

**Fan, Blowers and Compressors:** Classification of machines based on pressure rise. Axial fans: description of fans, fan stage parameters, fan laws and performance of axial fans. Centrifugal blowers: components of centrifugal blower, types, velocity diagram, stage parameters, design parameters, losses and efficiency centrifugal compressors: elements of a centrifugal compressor stage, vector diagrams, work done, effect of blade shape, stage parameters, degree of reaction, slip factor, stalling and surging phenomena in axialflow compressors: vector diagrams, work done factor, temperature and pressure ratio, degree of reaction.

**UnitV:**

**Power Transmitting Turbo Machines:**Application and general theory, their torque ratio,speed ratio, slip and efficiency, velocity diagrams, fluid coupling and torque converter and their characteristics.

**Positive Displacement Machines:**Positive displacement pumps with fixed and variable displacements hydrostatic systems: hydraulic intensifier, accumulator, press and crane.

**Recommended Books:**

1. Turbo machinery by D. G. Shepherd; MacMillan.
2. Steam Turbine: Theory and Practice by W. J. Kearton; CBS Publications.
3. Turbo machines by Csanady, McGraw-Hill Educations.
4. An introduction to Energy Conversion Vol. III – Turbo machinery by V. Kadambi and Manohar Prasad; Wiley Eastern Ltd. New Delhi.
5. Gas Turbine Theory by Cohen Rogers andSarvanMulto; Prentice Hall.
6. Fluid Mechanics and Fluid Machines by R. K. Bansal;Laxmi Publications.

**Suggested list of experiments:**

1. To study laboratory model of De-Laval turbine.
2. To study the laboratory model of velocity-compounded impulse turbine.
3. To study the laboratory model of pressure-compounded impulse turbine.
4. To study laboratory model of Pelton turbine and to its draw the main characteristics curves.
5. To study laboratory model of Francis turbine and to draw its main characteristics curves.
6. To study laboratory model of Kaplan turbine to draw its main characteristics curves.
7. To draw the performance characteristics curve of a single stage centrifugal pump.
8. To conduct a test on blower and to determine its overall efficiency.
9. To study the constructional details and working of axial flow compressor.
10. To study the constructional details of reciprocating pump and draw its characteristic curve.

**Course Outcomes (CO's)**

After completion of this course the student should be able to:

| CO | Statement |
|---|---|
| CO1 | Apply fluid dynamics concepts to analyze energy transformations in turbo machines. |
| CO2 | Understand details of steam turbines in reference to being a key component in thermal power station. |
| CO3 | Analyzing hydraulic machines applied in hydel power station. |
| CO4 | Studying the performance and characteristics of fans, blowers and compressors. |
| CO5 | Understand various applications of miscellaneous hydraulic systems utilized in power transmission. |

**Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 1 | 3 | 1 |
| CO2 | 3 | 3 | 3 | 3 | - | - | - | - | 2 | - | - | 1 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | - | - | - | - | 2 | - | - | 1 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | - | - | - | - | 2 | - | - | 1 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 | 3 | 2 |
| 1-Low, 2-Moderate, 3-High | | | | | | | | | | | | | | |

| B.E. VI SEMESTER MECHANICAL ENGINEERING | | | | | | | |
|---|---|---|---|---|---|---|---|
| COURSE CONTENTS (AICTE FLEXIBLE CURRICULA) | | | | | | | |
| **ME- 6331** | **Power Plant Engineering** | **L** | **T** | **P** | **C** | **Max. Marks** | **Min. Marks** |
| Duration | 3 Hours | 3 | - | 2 | 4 | 70 | 22 |

**Unit I**

**Introduction:** Energy resources and their availability, Indian energy scenario, types of power plants,review of basic thermodynamic cycles used in thermal power plants, combined power cycles

**Non-Conventional Energy Sources:**Introduction, solar energy, OTEC, solar photo-voltaic conversion, wind energy, geothermal energy, tidal energy, energy from biomass, MHD power generation, fuel cells, thermoelectric power generation, thermionic power generation

**Unit II**

**Thermal (Steam) Power Plant:** Flow sheet and working of modern-thermal power plants, power stationdesign, choice of steam cycle, site selection, fuel handling system, fuel firing systems, pulverized fuel firing, fluidized bed combustion, ash handling, dust collection, electrostatic precipitator, element of feed water treatment plant, condensing plant and circulating water systems, cooling towers, boiler, turbine.

**Unit III**

**Nuclear Power Station:** Introduction, advantages and disadvantages, site selection, review of atomic structure and radio activity, binding energy concept, fission and fusion reaction, fissionable and fertile materials, main parts of a heterogeneous nuclear reactor, moderator, coolant, classification of nuclear reactors, thermal and fast breeder reactors, basic reactor systems, fuel cycle, importance of nuclear power development in the Indian context.

**Unit IV**

**Hydro-Power Station:** Introduction, advantages and disadvantages, site selection, elements of hydrological computations, run off, flow duration curve, mass curve, storage capacity of reservoir, essential features of a hydroelectric power plant component such as dams, spillways, intake systems, head works, pressure tunnels, penstocks, reservoir, balancing reservoirs, surge tank etc., classification of hydroelectric power plants, selection of hydraulic turbines for power stations.

**Unit V**

**Power Station Economics:** Cost analysis, estimation and prediction of load, terms and definitions related to electrical load: maximum demand, load factor, diversity factor, plant factor and their influence on plant design; operation and economics; comparison of thermal, hydro and nuclear power plants, typical cost structures, economic performance, tariffs or energy rates, interconnected system and their advantages, elements of load dispatch in interconnected systems.

**Recommended Books:**

1. Power Plant Engineering by P.K.Nag;Tata McGraw Hill.
2. Power Plant Engineering by M.K. Gupta; Prentice Hall of India.
3. Power Plant Technology by M.M. Al-Wakil; Tata McGraw Hill.
4. Power Plant Engineering by P.C.Sharma;Kataria and sons, Delhi.
5. Power Plant Engineering by Domkundwar; DhanpatRaiand sons.
6. Power Plant Engineering by G.D.Rai;Khanna Publications.

**Suggested list of experiments:**

1. To study modern steam power plant.
2. To study various types of fuel & ash handling systems.
3. To study different types of dust collectors and pulverized fuel burners.
4. To study nuclear power plant.
5. To study Hydro power plant.
6. To study environmental impact of thermal power plant.
7. To study about different types of condensers and cooling towers.
8. To study about economics of power generation systems.
9. To study gas power plant.
10. To study combined steam & gas turbine power plant.

**Course Outcomes (CO's)**

After completion of this course the student should be able to:

| CO | Statement |
|---|---|
| **CO1** | Describe and discuss basics of power plant cycles and non-conventional energy sources. |
| **CO2** | Analyze the working of thermal power plant and its subcomponents. |
| **CO3** | Understand the principle of nuclear energy and to study various nuclear reactors. |
| **CO4** | Analyze various components of hydro power plant and parameters affecting it |
| **CO5** | Understand techno economic feasibility and its applications on power generating units. |

**Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | - | 2 | 2 | - | 2 | - | - | 2 | 3 | - |
| **CO2** | 3 | 2 | 2 | - | - | - | 3 | - | - | - | - | 2 | 3 | 1 |
| **CO3** | 3 | 3 | 2 | 2 | - | - | 2 | - | - | - | - | 2 | 3 | 1 |
| **CO4** | 3 | 3 | 3 | - | - | - | 2 | - | 2 | - | - | 1 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | - | - | - | - | - | 2 | - | 2 | 2 | 1 | 2 |
| **1-Low, 2-Moderate, 3-High** | | | | | | | | | | | | | | |