## Finalized Syllabus for KPSC Recruitment Examinations (Mechanical Engineering)

### 1. BASIC ENGINEERING

**Mechanical Engineering Science:** Energy and Steam, Forms, Sources and Classification of energy, Steam boilers – classification, Classification, Principle of operation of Impulse and reaction, gas & water turbine, Classification, I.C. Engines parts, Refrigeration and Air conditioning, Lathe and Drilling Machines, Milling and Grinding Machines, Joining Processes, Lubrication and Bearings Soldering, Brazing and Welding, Power Transmission: Belt Drives & Fasteners.

**Engineering Mechanics:** Introduction to engineering mechanics, Composition of forces, Free body diagram, Equations of equilibrium, Conditions of static equilibrium for different force systems, Lami's theorem, Friction, Statically determinate beams, Centroids and moment of inertia.

**Strength of Material:** Stress and strain, Shear stress, Bending moment and Shear force diagrams, Elastic constants, Principal stresses, Maximum stresses in beams, Deflection of beams, and Torsion of shafts.

**Engineering Drawing:** Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and free hand practicing, Orthographic Projections, Orthographic Projections of Plane Surfaces, Projections of Solids, Sections and development of lateral Surfaces of Solids, Isometric Projection (Using Isometric Scale Only), Computer Assisted Drafting/Modeling

#### Additional topics for graduate level and above

**Engineering Mechanics:** Statically indeterminate structures, Frames & trusses, Projectiles, Central force motion, Virtual work, Types of supports.

**Strength of Material:** Mohr's diagram, Column and struts, Slopes and deflection of beams, Combined stresses, Failure theories, Curved beams, Centrifugal stresses, Stresses in thin cylinders, Changes in dimensions of cylinder (diameter, length and volume), Thick cylinders subjected to internal and external pressures (Lame's equation)

### 2. ENGINEERING MATERIALS

**Material Science & Metallurgy:** Structure of crystalline solids, Diffusion, Diffusion Mechanism, Fick's laws of diffusion, Gibbs Phase rule, Binary phase diagrams, Iron-carbon Diagram, Mechanical Properties of Materials, Tension test, Hardness tests and Impact tests, Elastic and Plastic behavior, Yield point phenomenon, True stress-true strain relationships, Types of fracture, stages in cup & cone fracture, Fatigue: fatigue tests, S-N curves.

**Composite Materials:** Types of composite materials, Properties of fibers and matrix materials, General methods of production, properties and applications of FRP, PRC, MMC and structural composites. Expressions for density, Young's modulus, and strength of continuous fiber reinforced composites in iso – strain and iso – stress conditions. Applications of composite materials in aerospace, automobile and other fields.

#### Additional topics for graduate level and above

**Material Science & Metallurgy:** Factors affecting fatigue life and protection methods. Creep: The creep curves, Mechanisms of creep, Creep-resistant, Optical microscopy, Metallurgical microscope and specimen preparation, Scanning Electron Microscope. Space lattice classification, Miller Indices for planes and directions. Creep Phenomenon, Three stages of creep, Transient creep and Viscous creep, Creep rupture, Creep Properties, Creep Test, Iron-Carbon Equilibrium phases, Non- equilibrium T.T.T phase diagram. Phases formed in these conditions, Influence of alloying elements on Non equilibrium diagrams, Heat treatment of ferrous materials: Annealing, Normalising, Hardening, Tempering, Surface hardening methods: carburizing, cyaniding, nitriding, Flame and induction hardening, Heat treatment of Non-ferrous materials: Solutionising, precipitation hardening and aging

**Composite Materials:** Smart Materials: Piezo -electric materials, Electrostrictive, magnetostrictive materials, shape memory alloys, fiber optic sensors. Nano materials and Technology: Introduction, Overview of nano-science theory, Properties at nano-scale, Nano-materials, structures and nano-surfaces.

## 3. THERMAL & FLUIDS ENGINEERING

**Thermodynamics:** System, Surroundings, Boundary, Property, State, Process, Cyclic process, Path function, Point function, Zeroth law, First and Second of thermodynamics. Carnot cycle, Irreversibility and availability. Concept of Heat engines, efficiency of a heat engine – concept of heat pump and Refrigerator coefficient of performance.

**Fluid Mechanics:** Fluid-definition, concepts of continuum, shear stress as applied to fluids, fluid properties viscosity, Newton's law, surface tension, bulk modulus, compressibility, vapour pressure, capillarity, gauge and absolute pressures of a fluid. Principle of manometers, simple and differential manometers, Bourdon's pressure gauge, Pascal's law, Hydrostatic forces on plane and inclined surfaces. Archimedes principle, stability of floating bodies. Bernoulli's equation, viscous flow of incompressible fluids, boundary layers.

**I.C. Engines:** Working of SI and CI two-stroke and four-stroke engines. Efficiency calculation and heat balance.

**Power Plant Engineering:** Steam power: Coal, ash handling and different types of boilers: Diesel and gas turbine power plant: Hydro-electric plants: Nuclear power plant.

### Additional topics for graduate level and above

**Thermodynamic Engineering:** Behavior of ideal and real gases, properties of pure substance, calculation of work and heat in ideal processes, analysis of thermodynamic cycles related to energy conversion. Application of first law- Steady flow energy equations, Steady state flow processes, Applications of steady flow energy equations, Analysis of open system for different process. Entropy and heat, Carnot theorem, Clausius theorem, Entropy –property of a system, Clausius inequality, Entropy change of an irreversible process of a closed system, Principle of increase of entropy, combined first and second law, Entropy change for an ideal gas, True or internal latent heat, Internal energy of steam,dryness fraction, mollier chart.

**Fluid Mechanics:** Determination of Metacentric height - experimental and analytical methods. Forces acting on fluid mass, Eulers equation of motion, energy possessed by a fluid particle, Bernoulli's equation derivation from one dimensional Eulers equation of motion. Applications of Bernoulli's principle venturimeter, orifice meter, pitot tube, notches- rectangular, triangular, trapezoidal notches orifices: vertical, horizontal. Vortex motion, Reynolds number & its significance, Hagen poiseulles equation for flow through pipes, Turbulent flow: Darcy's equation for turbulent flow through pipes, Unsteady Flow-Water Hammer. Principle of dimensional analysis, Buckingham pi- theorem, application, dimensionless numbers and introduction to model studies.

**Turbo machinery:** Theory of turbines and classification of turbines, study of construction, working, velocity diagrams and efficiencies of Pelton- wheel, Francis and Kaplan turbines- Impulse and reaction principles and velocity diagram. Various types of steam and gas turbine, velocity diagrams. Reciprocating, centrifugal and axial flow compressors, multistage compression, reheat, regeneration, efficiency. Performance of turbines, specific speed and unit quantities, characteristic curves, cavitations, governing of turbines, model testing of turbines.

**Refrigeration & Air Conditioning:** Introduction - Application of refrigeration - Performance of a refrigerator (COP) - Units of refrigeration - The reverse cannot cycle - The reversed Brayton or Bell Coleman air cycle - Air refrigeration system - Vapour compression refrigeration system - Methods to improve simple refrigeration system - Properties of a good refrigerant – Vapour absorption refrigeration System – COP interms of operating temperatures of vapour absorption refrigeration system. Summer air conditioning & winter air conditioning,equipments used for air conditioning systems. Introduction to psychrometry, terms involved in air conditioning - Psychrometric chart - Psyctrometric processes - Concept of comfort air conditioning - Cooling loads affecting air conditioning.

**I.C. Engines:** Air standard efficiency & - mep of otto cycle – diesel cycle – dual combustion cycle numerical problems - deviation o Morse test f real cycle from theoretical air cycle. Theoretical air required, excess air actual air required for complete combustion of solid, liquid and gaseous fuels, analysis of products of combustion. Four stoke and two stroke cycle engines - Valve time diagram for four stoke engine combustion in SI Engines - detonation (KNOCK) in SI engines, combustion in CI engines & Knock in the CI engine. Carburetion - simple and complex carburetor - fuel pump for S.I engine - ignition systems for SI engines - fuel injection system for CI engine - Supercharging of IC engines - Cooling of IC engines - Governing of IC engines.

**Heat and Mass Transfer:** Basic modes of heat transfer, mechanism and basic laws of heat transfer, Thermal conductivity for various types of materials, heat capacity, heat diffusivity connective heat transfer co-efficient, Stefan Boltzmann's Law of Thermal radiation. Overall heat transfer co-efficient variable Thermal conductivity, critical thickness of insulation for cylinder and sphere, heat transfer from extended surfaces, Dimensional analysis, application to free and forced convection, physical significance of Reynolds, prandtl Nusselt and Stantan numbers numerical problems. Classification of heat exchangers, Heat changers effectiveness and LMTD for parallel and counter flows, fouling and fouling factor, significance of NTU. Types of boiling & condensation, Krichoff's law, Plank's law and Wein's displacement law, Radaiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces. Effect of radiation shield. Definitions of terms used in mass transfer analysis; Flick's first law, Steady state equimolar counter diffusion in gases; Steady state unidirectional in gases; steady state unidirectional in gases; steady state diffusion in liquids, Schmidt Number, Sherwood Number.

## 4. DESIGN

**Theory of machines:** Kinematic and dynamic analysis of planer mechanisms. Cams , gears and gear trains, transmission of power, friction, flywheels, governors, balancing of rotating and reciprocating masses, free and forced vibration of single degree freedom systems, effect of damping, transmissibility, vibration isolation, critical speed of shafts.

**Design of machine elements:** Design for static and dynamic loading; principles of the design of machine elements such as bolted, riveted and welded joints, shafts, springs, spur gears, rolling and sliding contact bearings, brakes and clutches. Lubrication & Bearings: Drop feed, wick feed and needle lubricators. Ring, splash and full pressure lubrication. Pivot bearing, collar bearings and antifriction bearings. Introduction to Computer Aided Design.

**Mechanical Measurements:** Measurements and measurement systems: Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, sensitivity, repeatability, linearity, standards of measurement, limits, fits, tolerance and gauging, principle of interchageability, Indian standards, comparators and angular measurement, mechanical and optical comparators, LVDT, Pneumatic comparators; Transducers, primary and secondary transducers, electrical, mechanical, electronic transducers; intermediate modifying and terminating devices: mechanical, cathode ray oscilloscope, oscillographs, X-Y plotters. Measurement of force, torque, pressure, temperature and strain.

## Additional topics for graduate level and above

**Theory of machines:** Velocity and acceleration of single slider mechanisms by analytical and Klein's Construction. Straight line motion: various mechanisms. Interference in gears and methods of avoiding interference; Minimum number of teeth on rack, pinion & gear when in mesh to avoid interference. Introduction to bevel, helical, spiral and worm gears (without involving problems). Classification: Velocity ratio for epicyclic gear train, evaluation tooth loads and torques in epicyclic gear train; Automobile gear box, Differential gear box. Principle of gyroscope motion: Spin, precession and torque vectors, gyroscopic and its effect on planes, ships, 2 wheelers and 4 wheelers. Static and dynamic balancing.

Balancing of rotating and reciprocating (primary and secondary forces) masses. Causes and effect of vibration in machines. Different methods of repreating of vector. S.H.M, degrees of freedom. Free, damped and forced vibration. Transmissibility and isolation. Free torsional vibration of shafts. Whirling of shafts. Geared System, Synthesis of Mechanisms.

**Design of machine elements:** The meaning of Mechanical Engineering Design – the phases of design – design considerations – codes and standards – review of stress analysis – factor of safety. Design for static loading – Failure theories – stress concentration. Design for variable loading – Endurance limit and fatigue strength – Fluctuating stress – combination of loading modes – Design of Impact loading. Design and selection of flexible machine elements. Types of bearings and their lubrication types. Properties of oil and equation of flow: Introduction to transmission elements-positive drivers and friction drives.

## 5. PRODUCTION & INDUSTRIAL ENGINEERING

**Metal Casting:** Gravity die-casting , pressure die casting, melting furnaces: working principle of choke fired, oil fired and gas pit furnace, electric arc furnace, welding process: arc welding: inert gas welding (TIG & MIG) submerged arc welding (SAW), gas welding: Acetylene welding, soldering & brazing.

**Metal cutting:** Cutting tool materials, basic tool geometry, mechanism of tool wear, tool life, metal cutting process: Turning, drilling, boring, milling, grinding & finishing process. Jigs and fixtures, principles. Carbides coated carbides. Turning (Lathe), shaping and planning machines: different operations on lathe, shaping machine drilling machines: CNC machines: Principles of operation milling machines: milling operations, indexing: differential and angular indexing calculations, grinding machines (centerless, cylindrical and surface grinding) broaching process: lapping and honing operations.

**Metal Forming:** Closed die forging by slab analysis, Rolling: Types of rolling mills, effects of front and back tensions, Drawing: Slab analysis, Extrusion: extrusion equipment & dies, deformation, extrusion of seamless tubes sheet & metal forming: Open back inclinable press (OBI press), piercing, blanking, bending, deep drawing, forming methods: explosive forming, electro hydraulic forming, electromagnetic forming, Power metallurgy: methods of production of metal powders, conditioning and blending powders.

**Computer Integrated Manufacturing systems:** WIP ratio, TIP ratio, High volume production system: Transfer mechanism-linear-walking beam, Rotary-rack and pinion, Rachet & pawl, geneva wheel, buffer storage, automated assembly systems: CNC machining centres. Computer controlled manufacturing systems, CNC machining centers and Programming, concept of group technology, cellular manufacturing, robotics, FMS.

**Non-Traditional machining:** Ultrasonic machining, Abrasive Jet Machining (AJM), Electrochemical Machining (ECM): Accuracy, surface finish, ECM tooling: ECM tooling technique, Chemical Machining (CM): Electrical Discharge Machining (EDM): EDM, Plasma Arc Machining (PAM), Laser Beam Machining (LBM).

**Industrial Engineering and Management:** Production planning, scheduling, routing, dispatching, ERP, push and pull production systems, supply chain management, inventory control. Quality-TQM, TPM, statistical quality control, six sigma, linear programming, simplex and duplex method, PERT and CPM. Design of Experiments- Taguchi method. Work Study: Introduction, Work-study procedures Human Considerations In work study concepts of work content, work study as a tool to improve productivity. Method Study: Objectives, steps in method study recording techniques, micro motion study, and principal of motion economy. Work Measurement: Objectives, techniques of work measurement, time study equipment, computation of standard time, work sampling predetermined motion time analysis.

### Additional topics for graduate level and above

**Production and Operation Management:** Historical evolution of POM, the system concept, system efficiencies and effectiveness, decision making for POM systems, role of models, the internal & external environment of POM, concepts of production and the measurement. Output design, materials & processing considerations design

specifications and tolerances, standardization & interchangeability, human engineering. Requirements of forecasting for operations, categories of forecasting methods, moving averaging method, exponential smoothing with trend and seasonality, forecasting errors, regression analysis, Delphi method, problems. Inventory types, Inventory costs, ABC's of inventory, EOQ models with and without shortage, production Inventory model, inventory model with price break, problems. Inventory types, Inventory costs, ABC's of inventory, EOQ models with and without shortage, production Inventory model, inventory model with price break, problems

**Automation in Manufacturing:** Automation-Definition, Reasons, Arguments for and against Automation Production Operations & Automation strategies-Manufacturing Industries, Types of Production, Functions in Manufacturing, Information Processing in Manufacturing, Plant layout, Production concepts & Mathematical models, Automation Strategies. Automated Material Handling & Storage system, Principles of Material Handling, Equipments, Automated Guided Vehicle systems-Components, Types, Guidance, Routing, Steering, Control, Loading, System design, Advantage & Applications. Automated Storage & Retrieval systems-Definition of ASRS, functions, components, Types & Design of ASRS, Distributed Control structure for AGVs & ASRS, Conveyors, Problems. Discrete Control using Programmable Logic Controllers & Personal Computers-Discrete Process Control- Logic Control & Sequencing, Ladder Logic Diagrams, Programmable Logic Controller- Components of PLC, operating cycle, Capabilities and Programming PLC, Problems. Pneumatic & Electro Pneumatics in Automation, Industrial Prime movers, Basics of Pneumatics, Compressed Air-generation & Contamination control, Pneumatic Actuators, Pneumatic Valves & Control Circuits, Building of Pneumatic Circuits for typical Automation applications. Control- Logic Control & Sequencing, Ladder Logic Diagrams, Programmable Logic Controller- Components of PLC, operating cycle, Capabilities and Programming PLC, Problems. Discrete Control using Programmable Logic Controllers & Personal Computers-Discrete Process. Pneumatic & Electro Pneumatics in Automation, Industrial Prime movers, Basics of Pneumatics, Compressed Air-generation & Contamination control, Pneumatic Actuators, Pneumatic Valves & Control Circuits. Building of Pneumatic Circuits for typical Automation applications.

**Automated manufacturing systems:** single station automated cells, flexible manufacturing systems, taguchi methods in quality engineering.

**Nanotechnology:** Nano scale-electron microscope. Fullerenes-conductivity and superconductivity- ferromagnetism. Carbon nanotubes, nanosensors electrochemical sensrs molecular nanomachines motors and machines nanotribology.

Note: The above syllabus is furnished such that the core is to be covered for all competitive examinations and the additional topics which are given at the end of each unit to be considered for questions in examinations seeking graduate or post-graduate background for aspirants. Questions with increased difficulty can be included for these examinations.