UPSC Mechanical Engineering Optional Syllabus 2026 for CSE Mains Paper 1 & 2

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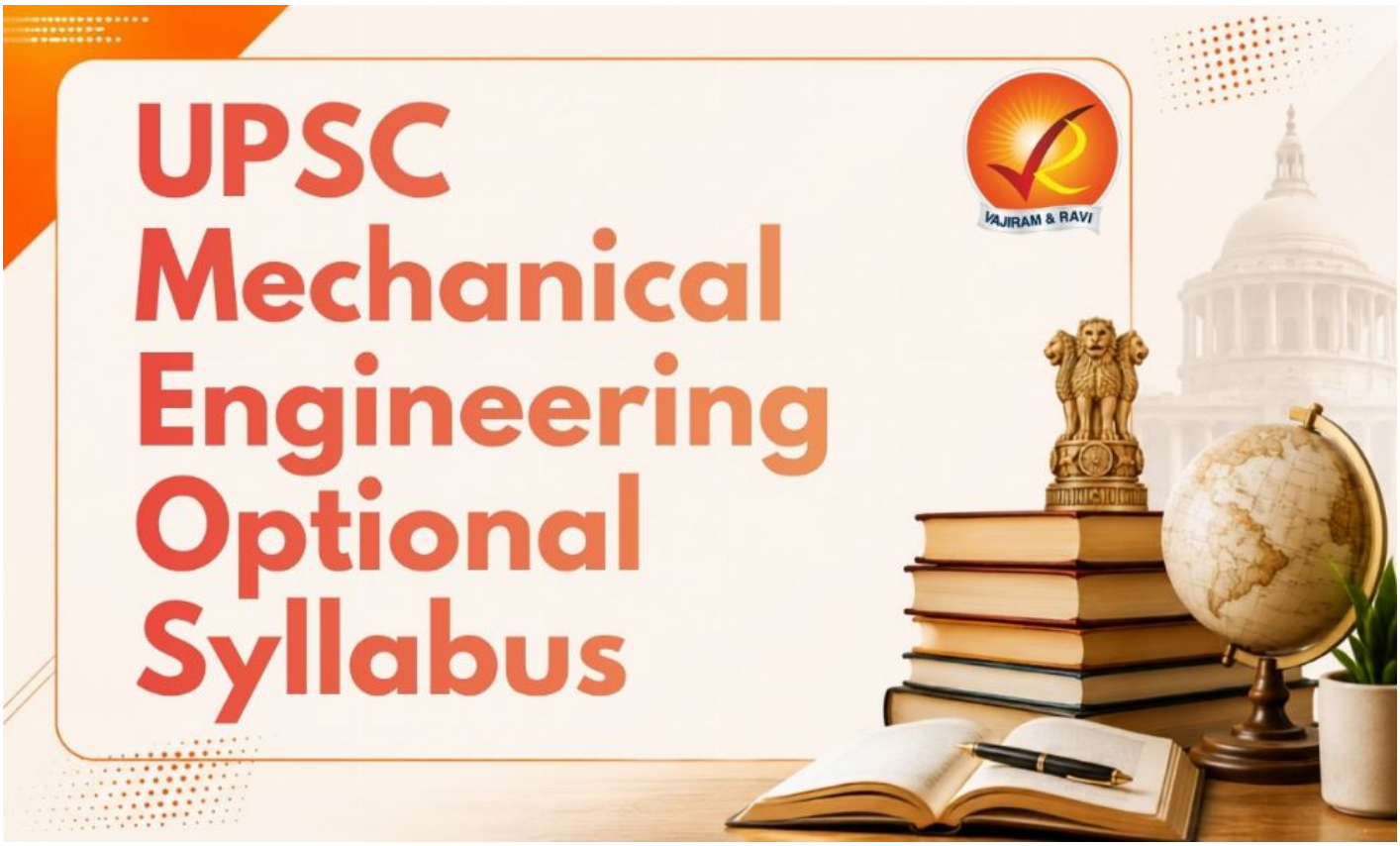

Mechanical Engineering in UPSC involves the design, development, and testing of systems, covering from machinery to components and even the human body. With its significant role in modern technology and infrastructure, it is offered as one of the 48 optional subjects in the UPSC Mains Exam, alongside Electrical Engineering and Civil Engineering.

The Mechanical Engineering optional includes two papers (Paper I & Paper II), each worth 250 marks, totaling 500 marks. It is a preferred choice for candidates with an engineering background, offering them a subject-specific advantage. This article covers the syllabus, recommended books, preparation strategy of selecting Mechanical Engineering as an optional subject.

UPSC Mechanical Engineering Syllabus

Mechanical Engineering is a preferred optional subject in the UPSC Mains Exam, especially for candidates with a background in Mechanical Engineering at the graduation or post-graduation level. On average, around 150 to 220 candidates choose Mechanical Engineering as their optional subject each year, with a success rate of approximately

10%. The subject's difficulty level is generally considered moderate, based on past exam analysis. To maximize their chances of success, candidates should align their preparation with the official UPSC Mechanical Engineering Syllabus.

UPSC Mechanical Engineering Syllabus for Paper 1

The UPSC Mechanical Engineering Syllabus for Paper 1 includes the topics covered during their engineering course including subjects like thermodynamics, cycles and IC engines, heat transfer and refrigeration, fluid mechanics, turbomachinery and power plants. For a detailed subject description, refer to the table below.

UPSC Mechanical Engineering Syllabus for Paper 1	
Mechanics	1.1 Mechanics of Rigid Bodies • Equations of equilibrium in space and its application; first and second moments of area; simple problems on friction; kinematics of particles for plane motion; elementary particle dynamics. 1.2 Mechanics of Deformable Bodies • Generalized Hooke’s law and its application; design problems on axial stress, shear stress and bearing stress; material properties for dynamic loading; bending shear and stresses in beams; determination of principal stresses and strains-analytical and graphical; compound and combined stresses; bi-axial stresses thin walled pressure vessel; material behaviour and design factors for dynamic load; design of circular shafts for bending and torsional load only; deflection of beam for statically determinate problems; theories of failure.
Engineering Materials	• Basic concepts on structure of solids , common ferrous and non-ferrous materials and their applications; heat-treatment of steels; non-metals plastics, ceramics, composite materials and nano-materials.
Theory of Machines	• Kinematic and dynamic analysis of plane mechanisms . Cams, Gears and epicyclic gear trains, flywheels, governors, balancing of rigid rotors, balancing of single and multi cylinder engines, linear vibration analysis of mechanical systems (single degree of freedom), Critical speeds and whirling of shafts.

Manufacturing Science	4.1 Manufacturing Process • Machine tool engineering - Merchant’s force analysis: Taylor’s tool life equation; conventional machining; NC and CNC machining process; jigs and fixtures. Non-conventional machining-EDM, ECM, ultrasonic, water jet machining etc.; application of lasers and plasmas; energy rate calculations. Forming and welding processes-standard processes. Metrology-concept of fits and tolerances; tools and gauges; comparators; inspection of length; position; profile and surface finish. 4.2 Manufacturing Management • System design: factory location—simple OR models; plant layout-methods based; applications of engineering economic analysis and break-even analysis for product selection, process selection and capacity planning; predetermined time standards. • System planning; forecasting methods based on regression and decomposition, design and balancing of multi model and stochastic assembly lines; inventory management-probabilistic inventory models for order time and order quantity determination; JIT systems; strategic sourcing; managing inter plant logistics. • System operations and control: Scheduling algorithms for job shops; applications of statistical methods for product and process quality control applications of control charts for mean, range, percent defective, number of defects and defects per unit; quality cost systems; management of resources, organizations and risks in projects. • System improvement: Implementation of systems, such as total quality management, developing and managing flexible, lean and agile Organizations.

UPSC Mechanical Engineering Syllabus for Paper 2

The UPSC Mechanical Engineering Syllabus for Paper 2 includes the topics like properties of materials, the principles guiding machinery and mechanisms, manufacturing techniques, and industrial engineering. For a detailed subject description, refer to the table below.

UPSC Mechanical Engineering Syllabus for Paper 2	
thermodynamics, Gas Dynamics Turbine	1.1 Basic concept of First-law and Second law of Thermodynamics; concept of entropy and reversibility; availability and unavailability and irreversibility. 1.2 Classification and properties of fluids; incompressible and compressible fluids flows; effect of Mach number and compressibility; continuity momentum and energy equations; normal and oblique shocks; one dimensional isentropic flow; flow of fluids in duct with frictions that transfer. 1.3 Flow through fans, blowers and compressors; axial and centrifugal flow configuration; design of fans and compressors; single problems compresses and turbine cascade; open and closed cycle gas turbines; work done in the gas turbine; reheat and regenerators.

Heat Transfer	2.1 Conduction heat transfer —general conduction equation-Laplace, Poisson and Fourier equations; Fourier law of conduction; one dimensional steady state heat conduction applied to simple wall, solid and hollow cylinder and spheres. 2.2 Convection heat transfer —Newton's law of convection; free and forced convection; heat transfer during laminar and turbulent flow of an incompressible fluid over a flat plate; concepts of Nusselt number, hydrodynamic and thermal boundary layer their thickness; Prandtl number; analogy between heat and momentum transfer—Reynolds, Calbom, Prandtl analogies; heat transfer during laminar and turbulent flow through horizontal tubes; free convection from horizontal and vertical plates. 2.3 Black body radiation —basic radiation laws such as Stefan-Boltzmann, Planck distribution, Wein's displacement etc. 2.4 Basic heat exchanger analysis ; classification of heat exchangers.
Engines	3.1 Classification, thermodynamic cycles of operation; determination of brake power, indicated power, mechanical efficiency, heat balance sheet, interpretation of performance characteristics, petrol, gas and diesel engines. 3.2 Combustion in SI and CI engines , normal and abnormal combustion; effect of working parameters on knocking, reduction of knocking; Forms of combustion chamber for SI and CI engines; rating of fuels; additives; emission. 3.3 Different systems of IC engines -fuels; lubricating; cooling and transmission systems. Alternate fuels in IC engines.
Steam Engineering	4.1 Steam generation —modified Rankine cycle analysis; Modern steam boilers; steam at critical and supercritical pressures; draught equipment; natural and artificial draught; boiler fuels solid, liquid and gaseous fuels. Steam turbines—Principle; types; compounding; impulse and reaction turbines; axial thrust. 4.2 Steam nozzles —flow of steam in convergent and divergent nozzle pressure at throat for maximum discharge with different initial steam conditions such as wet, saturated and superheated, effect of variation of back pressure; supersaturated flow of steam in nozzles, Wilson line. 4.3 Rankine cycle with internal and external irreversibility; reheat factor; reheating and regeneration, methods of governing; back pressure and pass out turbines. 4.4 Steam power plants —combined cycle power generation; heat recovery steam generators (HRSG) fired and unfired, co-generation plants.

Refrigeration and Air-conditioning	5.1 Vapour compression refrigeration cycle —cycle on p-H & T-s diagrams; eco-friendly refrigerants—R 134a. 123; Systems like evaporators, condensers, compressor, expansion devices. Simple vapour absorption systems. 5.2 Psychrometry —properties; processes; charts; sensible heating and cooling; humidification and dehumidification; effective temperature; air-conditioning load calculation; simple duct design.

UPSC Mechanical Engineering Optional Syllabus PDF

The UPSC Mechanical Engineering optional subject comprises two papers, Paper 1 and Paper 2, each carrying 250 marks, making a total of 500 marks. For the convenience of appearing candidates, the topic-wise UPSC Mechanical Engineering Optional Syllabus PDF for both Paper 1 and Paper 2 is available for download below.

UPSC Mechanical Engineering Optional Syllabus 2026 Preparation Strategy

Preparing for the Mechanical Engineering Optional in the UPSC Mains requires a focused and well-planned strategy. Candidates who are opting as optional subject can refer the below discussed UPSC Mechanical Engineering Optional Syllabus Preparation Strategy:

1. Carefully go through the syllabus for Paper 1 and Paper 2 to identify the key topics.
2. Choose standard textbooks and reference materials as per the syllabus for in-depth preparation.
3. Focus on problem-solving, particularly in subjects like Structural Analysis, Fluid Mechanics, and Transportation Engineering.
4. Analyze your performance after each test and revise challenging topics.
5. Allocate dedicated time for consistent revision and problem-solving to strengthen your understanding of Mechanical Engineering.
6. Consider joining a Mechanical Engineering Optional coaching or seeking mentorship for expert feedback and guidance.
7. Apply constructive feedback to improve your answer-writing skills and build a confident exam approach.
8. Prepare concise notes, especially for important formulas and concepts for quick revision.
9. Enhance your presentation and time management skills by solving previous year’s papers and participating in a test series.

UPSC Mechanical Engineering Optional Books

To effectively cover the Mechanical Engineering Optional Syllabus for the UPSC Mains, aspirants must build a solid foundation and gain an in-depth understanding of both basic and advanced concepts. Below we have shared the list of UPSC Mechanical Engineering Optional Books that an appearing candidate who is opting for the Mechanical Engineering as the optional subject:

UPSC Mechanical Engineering Optional Books	
Paper 1	Paper 2
• Callister’s Materials Science and Engineering • Theory of Machines by Rattan • Theory of Mechanism and Mechanics by Jagdish Lal • Machine Design by Shigley VB Bhandari • Manufacturing Technology by P N Rao • Principles of Manufacturing Material & Process by Campbell • Production Management by R K Jain • Mechanics of Solids by Popru • Strength of Materials by Gere & Timoshenko; BC Unamia; Sadhu Singh	• Thermodynamics by R Yadav • Fundamentals of Classed Thermodynamics by Van Wylen • IC Engine by ML Mathur and RP Sharma • Heat Conversion by Arora and Kundwar • Heat Transfer by Gupta Prakash • Gas Turbine and Propulsive Systems by PR Khajuria & SP Dubey • Refrigeration and Air Conditioning by CP Arora and Domkundwar • Heat and Mass Transfer by JP Hollman and RC Sachdeva

Other Related UPSC Optional Syllabus		
UPSC Commerce Optional Syllabus	**UPSC Geography Optional Syllabus**	**UPSC Geology Optional Syllabus**
UPSC History Optional Syllabus	**UPSC Law Optional Syllabus**	**UPSC Maths Optional Syllabus**
UPSC Medical Science Optional Syllabus	**UPSC Philosophy Optional Syllabus**	**UPSC Physics Optional Syllabus**
UPSC PSIR Optional Syllabus	**UPSC Psychology Optional Syllabus**	**UPSC Sociology Optional Syllabus**
UPSC Zoology Optional Syllabus	**UPSC Economics Optional Syllabus**	**UPSC Agriculture Optional Syllabus**
UPSC Anthropology Optional Syllabus	**UPSC Botany Optional Syllabus**	**UPSC Chemistry Optional Syllabus**
UPSC Civil Engineering Optional Syllabus	**UPSC Management Optional Syllabus**	**UPSC Mechanical Engineering Optional Syllabus**

Other Related UPSC Optional Syllabus		
UPSC Public Administration Optional Syllabus	**UPSC Statistics Optional Syllabus**	**UPSC Electrical Engineering Optional Syllabus**
UPSC Animal Husbandry & Veterinary Science Optional Syllabus		