Syllabus for PhD/M.Tech/MS written test

A candidate is required to attempt Mathematics and Basic English (compulsory for all) and any one of the following four streams (Fluid Mechanics and Thermal Sciences, Manufacturing Sciences, Robotics and Automation and Solid Mechanics and Design).

Mathematics (compulsory for all)

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

Fluid Mechanics and Thermal Sciences

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration: differential equations of continuity and momentum: Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow: flow through pipes, head losses in pipes, bends etc.

Heat Transfer: Modes of heat transfer, one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction. fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes: thermal boundary layer: effect of turbulence: radiative heat transfer, black and grey surfaces, shape factors, network analysis: heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics: thermodynamic system and processes; Carnot cycle. Irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion.

Manufacturing Sciences

Engineering Materials: Heat treatment; stress-strain diagrams for engineering materials.

Metal Casting and Joining Processes: Solidification and cooling in casting; riser and gating design; casting design considerations; physics of welding; solidification and cooling in welding.

Forming: Plastic deformation and yield criteria; load estimation for bulk (forging, rolling, drawing) and sheet (shearing, deep drawing, bending) metal forming processes.

Machining: Mechanics of machining; single and multi-point cutting tools; tool geometry and materials; tool life and wear; principles of non-traditional machining processes (USM, ECM, EDM, JM).

Metrology and Inspection: Limits, fits and tolerances; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Robotics and Automation

Kinematics and dynamics of particles and of rigid bodies in 2D; Free and forced vibrations.
Types of Robots, spatial transformations and kinematics of open chain linkages, dynamics, singularity and workspace analysis, basic robot control, programming in VAL Il, trajectory planning, industrial automation.

Solid Mechanics and Design

Free body diagrams and equilibrium; Kinematics and dynamics of particles and of rigid bodies in 2D; Free and forced vibrations of single degree of freedom systems (undamped and damped); Resonance; Stress and strain; Hooke's law; Mohr's circle for plane stress and plane strain; Shear force and bending moment diagrams; Bending and shear stresses; Thin cylinders; Deflection of beams; Failure theories.

The "Basic English" part of the test has no syllabus as such. General questions requiring high school level English proficiency will be asked. A sample question paper format is given below.

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Department of Mechanical Engineering, IIT Kanpur
PhD Admission Test
Basic English

Time: 15 minutes   Full Marks: 20

1. Find out if the sentences below have any error. For each sentence, identify the segment in which you find the error and suggest the correction.   (5 X 1 = 5)

(a) In order to sustain the operation,   (1) /   the company has already took   (2) / appropriate steps to identify   (3) /   alternative agencies at various places.   (4) / No error. (5)

   Ans. *(2) the company has already taken*

(b) .... (1) /   .... (2) /   .... (3) /   .... (4) /   No error. (5)
   Ans. _____

(c) ....
   Ans. _____

(d) ....
   Ans. _____

(e) ....
   Ans. _____

2. In the passage below, some letters from a few words are replaced by asterisks (*). Identify those words.   (5 X 1 = 5)

   Unconscious of my presence, he began to pace the room in a state of fearful **(a) *g*t**i*n**, violently wringing his hands and **(b) u*t**i*g** low groans or **(c) *n*o*e*e*t** ejaculations. I made a movement to let him know that he was not alone; but he was too   **(d) p*e*c*u*i*d** to notice it. Perhaps, while his back was towards me, I might cross the room and slip away **(e) *n*b**rv*d**.

   Ans: (a) *agitation*,   (b) *uttering*,   (c) *incoherent*, (d) *preoccupied*,   (e) *unobserved*.

3. A context will be given and the candidate will be asked to draft the text of a brief email (**strictly within 80 words**) in that context.   (10)

   Example: Your boss gave you some task which you had to complete and report the results to him in a meeting on Tuesday. Due to some unexpected circumstances, your work has got delayed. Draft the text of an email (strictly within 80 words) to explain the situation to him and seek an appointment for Thursday instead.