

# Basic studies syllabus

## Basic studies examinations

### Group A - Compulsory examinations (four required)

#### 20-BS-A1 Mathematics

Vector and Linear Algebra: Applications involving matrix algebra, determinants, eigenvalues and eigenvectors, vector functions and operations, orthogonal curvilinear coordinates. Calculus: first and second order linear ordinary differential equations, series solutions of ordinary differential equations, applications of partial derivatives, Lagrange multipliers, multiple integrals, line and surface integrals, integral theorems (Gauss, Green, Stokes). Power series.

*Textbooks (most recent edition is recommended):*

- Erwin Kreyszig and Herbert Kreyszig: Advanced Engineering Mathematics, Wiley (open textbook)
- J. Bass : Cours de mathématiques, Tome 1, fascicule 1, Masson
- J. Bass : Cours de mathématiques, Tome 2, Masson

#### 20-BS-A2 Probability and Statistics

Concepts of probability, events and populations, probability theorems, concept of a random variable, continuous and discrete random variables, probability distributions, distributions of functions of a random variable, sampling and statistical estimation theory, hypothesis testing, simple regression analysis.

*Textbooks (most recent edition is recommended):*

- Anthony Hayter: Probability and Statistics for Engineers and Scientists (open textbook)
- G. Baillargeon : Probabilités et statistique avec applications en technologie et ingénierie, Les Éditions SMG

#### 20-BS-A3 Computation Methods

Use of computers for numerical solution of engineering problems, including techniques involving high-level languages and other computational tools (e.g., spreadsheets). Data representation, approximations and errors.

*Textbooks (most recent edition is recommended):*

- S.C. Chapra: Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw Hill (open textbook)
- H.M. Deitel et P.J. Deitel : C How to Program, Prentice Hall (open textbook)
- Hans Petter Langtangen: A Primer on Scientific Programming with Python, Springer (open textbook)
- C. Delannoy : Programmer en langage C – cours et exercices corrigés, Éditions Eyrolles (open textbook)

#### 20-BS-A4 Engineering Design Process

Design process and methods. Project management & teamwork. Requirements and function analysis in design. Conceptual design and testing. Concept evaluation design factors such as: cost, quality, manufacturability, safety, etc. Systems modelling & design detail.

*Textbooks (most recent edition is recommended):*

- G.E. Dieter and L.C. Schmidt: Engineering Design, McGraw-Hill

## Group B - Optional examinations (six required)

### 20-BS-B1 Statics and Dynamics

Force vectors in two- and three-dimensions, equilibrium of a particle in two- and three-dimensions; moments and couples; equilibrium of rigid bodies in two- and three-dimensions; centroids, centres of gravity; second moment of area, moment of inertia; truss, frame and cable static analysis; friction. Planar kinematics of particles and rigid bodies; planar kinetics of particles and rigid bodies; work and energy, impulse, and momentum of particles and rigid bodies.

*Textbooks (most recent edition is recommended):*

- R.C. Hibbeler: Engineering Mechanics: Statics and Dynamics
- J.L. Meriam and L.G. Kraige: Engineering Mechanics, Wiley and Sons (open textbook)
- F.P. Beer and E.R. Johnston: Mechanics for Engineers, Statics and Dynamics, McGraw-Hill (Also available as F.P. Beer and E.R. Johnston: Vector Mechanics for Engineers, Statics, McGraw-Hill and F.P. Beer and E.R. Johnston: Vector Mechanics for Engineers, Dynamics, McGraw-Hill)
- F.P. Beer et E.R. Johnston : Mécanique à l'usage des ingénieurs, Statique
- Gilles Génier et collaborateurs : Cahier de statique, École Polytechnique de Montréal

### 20-BS-B2 Electric Circuits and Power

Current, voltage, Ohm's law, Kirchoff's voltage and current laws, power; DC circuits, network theorems, network analysis; simple transients, AC circuits. Impedance concept, resonance; application of phasors and complex algebra in steady-state response; application of Laplace transforms; simple magnetic circuits; basic concepts and performance characteristics of transformers; an introduction to diodes and transistors; rectification and filtering; simple logic circuits.

*Textbooks (most recent edition is recommended):*

- J.W. Nilsson and S.A. Riedel: Electric Circuits, Pearson (open textbook)

### 20-BS-B3 Mechanics of Materials

Definitions of normal stress, shearing stress, normal strain, shearing strain; shear force and bending moment diagrams; members subjected to axial loading; members subjected to torsional loading; compound stresses, Mohr's circle; deformation of flexural and torsional members; failure theories; elastic and inelastic strength criteria; columns.

*Textbooks (most recent edition is recommended):*

- R.C. Hibbeler, Mechanics of Materials, Pearson (open textbook)
- A. Bazergui, T. Bui-Quoc, A. Biron, G. McIntyre et C. Laberge : Résistance des matériaux, Éditions de l'École Polytechnique de Montréal
- W.A. Nash : Résistance de matériaux, Série Schaum, McGraw-Hill

### 20-BS-B4 Mechanics of Fluids

Fluid characteristics, dimensions and units, flow properties, and fluid properties; the fundamentals of fluid statics, engineering applications of fluid statics; the one-dimensional equations of continuity, momentum, and energy; laminar and turbulent flow, flow separation, drag and lift on immersed objects; wall friction and minor losses in closed conduit flow; flow of incompressible and compressible fluids in pipes; dimensional analysis and similitude; flow measurement methods.

*Textbooks (most recent edition is recommended):*

- P. J. Pritchard and J. W. Mitchell: Fox and McDonald's Introduction to Fluid Mechanics (open textbook)
- J.-P. Beaudry et J.-C. Rolland : Mécanique des fluides appliquée, Éditions Berger

## 20-BS-B5 Digital Logic Circuits

Boolean algebra, truth tables and minimization techniques. Logic devices, combinational logic, encoders, decoders and shift registers. Design of asynchronous circuits and synchronous circuits, arithmetic circuits and finite state machines together with clock and timing considerations. Introduction to programmable logic and computer-aided design and simulation tools for digital system design.

*Textbooks (most recent edition is recommended):*

- John F. Wakerly: Digital Design Principles and Practices, Prentice Hall
- X. Maldague : Circuits Logiques, Loze-Dion Éditeurs

## 20-BS-B6 Basic Electromagnetics

Introduction to the fundamental electromagnetic fields and forces used in engineering, including fundamental laws, principles, and equations developed by Gauss, Faraday, Ampere, Kirchoff, Maxwell, leading to electromagnetic design and applications in engineering, such as for capacitors, dielectrics, and magnetic devices.

*Textbooks (most recent edition is recommended):*

- N. Narayana Rao: Elements of Engineering Electromagnetics, Prentice Hall (open textbook)

## 20-BS-B7 Thermodynamics

Basic concepts and definitions, energy concepts and the first law of thermodynamics, properties of pure substances, closed systems, open systems, the second law of thermodynamics, enthalpy, entropy, exergy, gas power cycles, vapor and combined power cycles, refrigeration cycles.

*Textbooks (most recent edition is recommended):*

- Y.A. Cengel and M.A. Boles, Thermodynamics: An Engineering Approach, McGraw-Hill
- Y.A. Çengel, M.A. Boles, M. Lacroix : Thermodynamique : une approche pragmatique, Les éditions de la Chenelière McGraw-Hill

## 20-BS-B8 Properties of Materials

Properties of materials for mechanical, thermal and electrical applications. Atomic bonding, solid solutions, crystallisation. Equilibrium phase diagrams, applications to steel and aluminium alloys, heat treatments. Structure and special properties of polymers and ceramic materials. General characteristics of metallic composites, polymeric composites and concrete. Introduction to materials in hostile environments: corrosion, creep at high temperature, refractory materials, subnormal temperature brittle fracture.

*Textbooks (most recent edition is recommended):*

- W.D. Callister Jr. and D.G. Rethwisch: Materials Science and Engineering: An Introduction, Wiley (open textbook)
- Jean-Paul Baillon et Jean-Marie Dorlot : Des matériaux, Éditions de l'École Polytechnique de Montréal

## 20-BS-B9 Organic Chemistry

Principles of organic chemistry developed around the concepts of structure and functional groups. The main classes of organic compounds. Properties of pure substances. Introduction to molecular structure, bond types, properties, synthesis and reactions, reaction mechanisms, as a means of systematizing organic reactions.

*Textbooks (most recent edition is recommended):*

- J. Clayden, N. Greeves and S. Warren: Organic Chemistry, Oxford (open textbook)
- K.P.C. Vollhardt : Traité de chimie organique

## 20-BS-B10 Biology

Cellular reproduction, growth, and differentiation; metabolism and bioenergetics of living cells; cell structure and function related to the material properties of plant and animal tissues; introductory microbiology — characteristics and classification of microorganisms; interactions of microorganisms with humans in the natural world; kinetics and mathematical models of microbial growth; engineered biological systems such as bio-reactors, bio-instrumentation, bioprinted devices and waste treatment systems for sustainability.

*Textbooks (most recent edition is recommended):*

- M.T. Madigan, J.M. Martinko and J. Parker: Brock Biology of Microorganisms, Prentice Hall / Pearson Education

## 20-BS-B11 Geology

The structure of the earth, plate tectonics, earthquakes and igneous activity. Minerals and rocks including their formation, identification, basic properties, and classification. Processes of weathering, erosion, transport, and deposition of geological materials and their results of significance to engineering. Occurrence, flow, and quality of groundwater. Introductory aspects of structural geology including faulting, folding, and the overall formation of discontinuities and their effect on the engineering properties of rock masses. Aerial photography and geological maps.

*Textbooks (most recent edition is recommended):*

- T.R. West: Geology applied to Engineering, Prentice Hall
- S. Earle: Physical Geology, BCcampus (<https://opentextbc.ca/geology/>)
- B. Landry et M. Mercier : Notions de géologie, Modulo Éditeur

## 20-BS-B12 Engineering Graphics

Engineering drawing: Orthographic sketching. Standard orthographic projection. Principal views, selection and positioning of views. Visualization. Conventions and practices. First and second auxiliary views. Basic descriptive geometry. Section views, types, hatching conventions. Basic dimensioning requirements. Tolerance for fits and geometry control. Detail drawings and assembly drawings, other drawings and documents used in an engineering organization. Bill of materials. Fasteners and welds.

*Textbooks (most recent edition is recommended):*

- J.H. Earle: Engineering Design Graphics, Prentice Hall
- Giesecke, Mitchell, Spencer, Hill, Dygdon: Dessin technique, ERPI

## 20-BS-B13 Advanced Mathematics

Solutions of differential equations, boundary value problems and orthogonal functions, Fourier series, complex variable analysis

*Textbooks (most recent edition is recommended):*

- E. Kreyszig: Advanced Engineering Mathematics, Wiley (open textbook)
- J. Bass : Cours de mathématiques, Tome 1, fascicule 1, Masson
- J. Bass : Cours de mathématiques, Tome 2, Masson