Mechatronics engineering syllabus

Mechatronics engineering examinations

Group A - Compulsory examinations (seven required)

16- Mechatronics-A1 System Analysis and Control

Open-loop and feedback control. Laws governing mechanical, electrical, fluid, and thermal control components. Mathematical models of mechanical, hydraulic, pneumatic, electrical and control devices. Block diagrams, transfer functions, response of servomechanisms to typical input signals (step function, impulse, harmonic), frequency response, Bode diagram, stability analysis, and stability criteria.


Textbooks (most recent edition is recommended):

- Franklin, Feedback Control of Dynamic Systems.

16- Mechatronics-A2 Circuits


Textbooks (most recent edition is recommended):


16- Mechatronics-A3 Electronics

Semiconductor devices; diodes and thyristors. Bipolar and field effect transistors as linear devices and switches. Bias circuits, basic amplifiers, small-signal equivalent circuits, transfer functions, and frequency response. Operational amplifiers and comparators. Digital integrated circuits and logic families: TTL, TTL-LS, and CMOS.

Textbooks (most recent edition is recommended):


16- Mechatronics-A4 Digital Systems and Computers

Combinational, sequential, and synchronous logic circuits. Register level design of digital systems. Computer arithmetic, central processing unit, memory systems and peripherals. Assembly language programming, interrupts, and interfacing and communication. Computer architecture.

Textbooks (most recent edition is recommended):


16- Mechatronics-A5 Applied Thermodynamics, Fluid Mechanics, and Heat Transfer
Thermodynamics: Review of the fundamental laws of thermodynamics, introductory psychrometry and analysis of the ideal gas compressor cycle, Rankine cycle, Otto cycle, Diesel cycle, Brayton cycle and the vapour compression refrigeration cycle.


Textbooks (most recent edition is recommended):

### 16- Mechatronics-A6 Kinematics and Dynamics of Machines

Kinematic and Dynamic Analysis: Graphical and analytical methods for kinematic analysis of planar and spatial mechanisms and elementary body motion in space, static and dynamic force analyses of mechanisms, gyroscopic forces, dynamics of rotating machinery, cam and gear mechanisms and specifications.

Vibration Analysis: Free and forced vibration of undamped and damped lumped single and multi degrees of freedom systems with, analytical and numerical techniques of solution, viscous damping, vibrational isolation, vibration measurement and control.

Textbooks (most recent edition is recommended):

### 16- Mechatronics-A7 Power Systems and Machines


Textbooks (most recent edition is recommended):

### Group B - Optional examinations (three required)

### 16- Mechatronics-B1 Signals and Communications

Analysis of continuous-time signals: Fourier series and Fourier transform; magnitude, phase, and power spectra. Analysis of discrete-time signals: Nyquist sampling theorem; the Z-transform. Analog communication systems: amplitude and frequency modulation and demodulation. Digital communication systems: pulse code modulation; bandpass modulation and demodulation techniques.

Textbooks (most recent edition is recommended):

Or
16- Mechatronics-B2  Digital Signal Processing

Discrete-time signals and systems: system input-output and convolution, Z-transform and transfer functions. Discrete-time Fourier transform (DFT) and Fast Fourier transform (FFT). Design of finite impulse response (FIR) and infinite impulse response (IIR) filters. DSP implementation considerations.

Textbooks (most recent edition is recommended):


16- Mechatronics-B3  Advanced Control Systems


Textbooks (most recent edition is recommended):


16- Mechatronics-B4  Environmental Control in Buildings


Energy management technology: Energy usage in buildings, control systems and instrumentation, lighting systems operation, engineering/economic analysis principles, energy audit procedures.

Textbooks (most recent edition is recommended):


16- Mechatronics-B5  Acoustics and Noise Control


Textbooks (most recent edition is recommended):

Primary Text:

Secondary Text:

16- Mechatronics-B6  Robot Mechanics

Robot components (sensors, actuators, and end effectors, and their selection criteria); basic categories of robots (serial and parallel manipulators, mobile robots); mobility/constraint analysis; workspace analysis; rigid body kinematics (homogeneous transformation, angle and axis of rotation, Euler angles, cylindrical and spherical coordinates); manipulator kinematics and motion trajectories (displacement and velocity analyses, differential relations, Jacobian matrix); non-redundant and redundant sensing/actuation of manipulators; manipulator statics (force and stiffness); singularities; and manipulator dynamics.

Textbooks (most recent edition is recommended):

16- Mechatronics-B7  Power Electronics and Drives


Textbooks (most recent edition is recommended):

16- Mechatronics-B8  Design and Manufacture of Machine Elements

Theory and methodology related to conceptual design; review of the methods used in stress analysis; simple design factor approach; variable loads; stress concentrations; bolts and bolted joints; welded joints; springs; shaft and bearing design; clutches, brakes, and braking systems.

The role and characterization of manufacturing technology within the manufacturing enterprise is also examined. Topics include an overview of the deformation process, joining processes, consolidation processes, material removal processes, material alteration processes; composites manufacturing, nano- and-microfabrication technologies rubber processing, glass working, coating processes, mechanical assembly, electronics packaging and assembly, and production lines; and process selection and planning; quality control systems.

Textbooks (most recent edition is recommended):

16- Mechatronics-B9 Product Design and Development

Modern tools and methods for creative product design and development involving product research, establishment of design parameters, experimentation, development of conceptual alternatives, visualization, evaluation, revision, optimization and presentation. Particular topics include: The engineering design process, development processes and organizations, product
planning, identifying customers needs, product specifications, concept generation, concept selection, prototyping, robust design, concept testing, product architecture, industrial design, design for manufacturing, patents and intellectual property, product development economics, and managing mechatronic-related projects.

Textbooks (most recent edition is recommended):

Primary Text:

Secondary Text:

16- Mechatronics-B10 Integrated Manufacturing Systems

Production automation and the role of the computer in modern manufacturing systems via an comprehensive overview of applications of advanced technologies in manufacturing and their business impact on the competitive dimensions of cost, flexibility, quality and deliverability. Particular topics include: facility layout; cellular manufacturing; fundamentals of automation, numerical control programming, material handling and storage, automatically-guided vehicles, flexible manufacturing systems, group technology, programmable logic controllers, concurrent engineering, production planning and control, production activity control systems, automatic identification and data collection, lean and agile manufacturing, computer-aided process planning, forecasting, inventory management and control, quality control and inspection and inspection technologies.

Textbooks (most recent edition is recommended):