Final examination questions

for the qualification of *inżynier* (BSc equivalent)

in Mechanical Engineering

Full-time programme

Questions for all students taking the first-cycle programme in Mechanical Engineering

FUNDAMENTALS OF CONTROL ENGINEERING

1. Describe the basic components of analogue and digital control systems.
2. Give the definition of the Laplace transfer function and discuss its use for the analysis of continuous-time linear time-invariant systems.
3. Discuss the types and applications of the frequency response (frequency characteristics) of control systems and their components. Interpret the plots.
4. Discuss PID algorithms (transfer function, controller settings, effects of the proportional, integral and derivative actions).
5. Stability of a linear time-invariant control system and methods to determine it.

Discuss the types and applications of frequency characteristics of control systems and its components. Interpret the plots.

METAL SCIENCE

1. What materials are used for high-speed cutting tools?
2. What is work hardening and what are its effects?
3. How to remove work hardening effects, e.g. in sheet-metal forming for steel?
4. What is steel, cast steel, and cast iron?
5. What are the phases in carbon hypoeutectoid steel?
6. Which steels can be used in corrosive environments?
7. What does quenching involve?
8. Basic division of hardness testing methods.
9. Classification of aluminium alloys.
10. Classification of copper alloys.

ENGINEERING MECHANICS

1. The significance of and the principles to determine the resultant of a system of non-concurrent forces acting on a rigid body.
2. Friction.
3. Rigid body dynamics: translation and rotation about a fixed axis.
4. The work-energy theorem.
5. Damped oscillations.

FLUID MECHANICS

1. Viscosity vs density of a fluid. Dynamic vs kinematic viscosity.
2. Basic equation of fluid statics.
3. Continuity equation.
4. The Bernoulli equation and its graphical forms (energy and hydraulic grade lines) for an inviscid fluid.
5. Write the Bernoulli equation including energy losses and the Coriolis coefficient.

METROLOGY

1. What is metrology and what problems does it deal with?
2. What is the International System of Units (SI)? What are the SI base units?
3. What is a measurement error? What are the types of measurement errors?
4. Name the methods used to measure length.
5. What is surface roughness? Define the Ra parameter.

HYDRAULIC AND PNEUMATIC POWER AND CONTROL

1. What are the SI units for pressure, mass and volume flow rate, and viscosity of a fluid?
2. Draw the graphic symbol of any component of hydraulic and pneumatic control systems.
3. Name elements of a hydraulic control system.
4. Name elements of a pneumatic control system.
1. Give examples of use of hydraulic and pneumatic control systems in manufacturing equipment.

FUNDAMENTALS OF COMPUTER SCIENCE

1. Discuss the conditional statement (if statement) and the select case statement in Scilab.
2. Discuss for and while loops in Scilab.
3. Discuss methods to assign values to matrix variables in Scilab.
4. Discuss the Scilab tools: SciNotes and Xcos.
5. Discuss ways to create plots in Scilab.

MACHINE DESIGN

1. How do you determine the strength of a round bar under a constant torque?
2. How do you determine the offset yield strength?
3. Discuss the S-N curve.
4. What does the power screw efficiency depend on?
5. What are the failure criteria for a riveted joint?
6. What is the pressure angle?
7. Discuss the advantages of profile shifting?
8. Discuss the Hertzian contact problem.
9. Name the applications for couplings and clutches.

10. Discuss the main differences between sliding contact bearings and rolling contact bearings.
11. Discuss the stress distribution in a belt of a flat belt drive?
12. Derive a relation between pitch and pitch circle diameter.

MANUFACTURING PROCESSES

1. Classification of rolling processes and rolled products.
2. Classification of machining operations.
3. Methods of cutting.
4. Cutting tools materials.
5. Material removal methods to create a flat surface.
6. Methods to remove material from a rotating workpiece.
7. Drawing and redrawing of cylindrical pieces.
8. Open-die forging. Die forging with and without flash.
9. Name the joining processes and explain the main differences between them.
10. Name and briefly characterize the most common arc welding methods.
11. Sheet metal forming processes.
12. Discuss 3D printing technologies. Creating a digital model.

THERMODYNAMICS

1. Derive a formula of the ideal gas equation of state. Explain the difference between the universal gas constant and the specific gas constant.
2. Discuss the first law of thermodynamics for open (control volume) and closed systems.
3. Define the coefficient of performance (COP) for heat pumps and the energy efficiency ratio (EER) for a refrigerator/an air conditioner.
4. Discuss the Carnot cycle plotted on a T-V, P-V or T-S diagram; define the efficiency of a heat engine using the Carnot cycle.
5. Show the liquid region, the saturated liquid-vapour (wet saturated vapour) region, the superheated vapour region, the saturated liquid line, and the saturated vapour line on a P-V diagram.

STRENGTH OF MATERIALS

1. Define stress. What units is stress expressed in?
2. Explain the terms: deformation and displacement.
3. Shear modulus vs Young's modulus vs bulk modulus.
4. Torsional rigidity vs flexural rigidity of a metal round bar. The physical significance of Euler's critical load (eccentric bending) when applied to a metal bar.
5. Draw a Mohr's circle for plane stress.

QUALITY ENGINEERING

1. Explain the terms: quality, reliability and durability of a product.
2. What is a control chart?
3. Discuss the process capability indices.
4. Explain the terms: repeatability and reproducibility of a measuring system.
5. Structure of the quality management system documentation.

Questions for students specializing in:

COMPUTER-AIDED MANUFACTURING

1. Classification of measuring instruments according to the display device.
2. Principles of die forging design.
3. Classification of joining processes.
4. Abrasive machining: processes and applications.
5. Steps involved in the casting process.
6. Roughing and finishing for hole making.
7. Classification of metal forming machines.
8. Methods to represent measuring instruments.
9. Examples of robots and manipulators used in manufacturing.
10. CNC programming using CAD/CAM software.
11. Discuss basic casting materials.
12. Machining in today's manufacturing.
13. What is a histogram? Give a graphical example.
14. What does manual CNC programming involve?
15. Discuss the architecture of CNC control software.
16. Classification of errors according to their source.
17. Types of extrusion. Examples of extrudates (products of extrusion).
18. Classification of drawing machines.
19. Types of welded joints and welds.
20. Principles of deep drawing design.
21. 3D printing of thermoplastic materials by fused deposition modelling (FDM): process and materials.