THEMATIC AREAS FOR THE EXPERT DISCOURSE AT FINAL STATE EXAMINATION

Master Study Programme: **Innovation and Industrial Engineering** (N0788A270005)

A. „ INNOVATION ENGINEERING METHODS “

1. Definition and basis of innovation engineering. Innovation rules. Innovation cycle. Innovation engineering methods. (description, introduction of methods).
2. Systematic planning of technical innovation. Market analysis. Trend analysis. Technology Roadmapping. Innovation opportunities/ideas and their evaluation. Innovation statement. (description).
3. Specification of user and customer needs. Needs identification methods. Affine diagram. (description, introduction of procedure).
4. QFD method (principle, procedure), ISQ method. (principle, procedure).
5. Systematic survey of the state of the art. (procedures and sources for searches in patent and non-patent sources).
6. Methods of innovative creativity. Morphological matrix. Invention principles. (introduction of methods, principle of morphological matrix, examples of inventive principles).
7. FMEA method (principle, procedure).
8. Architecture of an innovated product. Dependent and modular architecture. MFD method. Design Structure Matrix. (description).
9. Selection of an innovated product concept. Pugh method. Multi-criteria evaluation of concepts. AHP method. (description, procedure).
10. Conventional methods for solving problems – principle of methods, examples of methods, advantages and disadvantages, levels of inventions, systematic methods – introduction of levels of inventions, introduction of the essence of the TRIZ method.
11. Analysis of functions and components of a technical system (product, device), functional-object analysis (FOA), simplification of the design of a technical system while maintaining its functions (trimming) – principle, trimming rules, procedure.
12. Finding the root causes of shortcomings of a technical system (RCA/RCA+ analysis) – principle, procedure.
13. Mapping the state of the art and predicting development using trends in technical system development (TESE) – procedure, examples of trends in the evolution of technical systems, Analysis of the development phase of a technical system according to the so-called S-curve – principle, procedure.

14. Technical contradictions and methods of resolving them – defining the contradiction, introduction of the solution procedure, physical contradictions and methods of resolving them – defining the contradiction, introduction of the solution procedure.
15. Inventive principles – essence, use, examples of principles, separation principles – essence, use, presentation of principles.

B. „PRODUCT DESIGN“

1. PLM, product development from the perspective of resources, methods and external influences and internal measures (basic axioms of PLM systems, PLM and designer, PLM and customer relationship, new powerful technologies, globalization issues).
2. CAD systems and their implementation into PLM. PDM, EDM systems, Smartteam, Windchill (possibilities of these systems, practical use, concepts of client, server, role, change management).
3. DFA (Design for Assembly) general principles (how to proceed when designing an assembly according to DFA principles, examples of practical solutions, issues of joints).
4. Product design factors dependent and independent of the principles of assembly creation and their procedures (product design methodology from the perspective of its assembly, basic rules and principles for manual assembly, assessment of the suitability of assembly design).
5. Product structure, modular design solutions for complex assemblies, automated assembly (methods and possibilities of product optimization using properties, modern CAD technology, what can be simulated).
6. New technologies and their use for DFA (new fasteners and their calculations, orientation and stability of parts during their assembly for both manual and automated assembly, unusual, inadmissible design solutions of products from the point of view of assembly and production).
7. DFM (Design for Manufacturing) – design from the point of view of production (generally distinguish from the point of view of product design into piece, small-series and large-series production and single-purpose equipment, which are highly productive production methods often used today). DFMA – methods and evaluation of two opposing views of assembly and production (price approach, minimization of production and assembly costs).
8. DFM – modern and classic materials, mechanical properties, composites, plastics, high-strength sheets (description). DFM - forgings, sheet metal stampings, welded joints. (formation of sheet metal, pipes, distribution, pneumatic and hydraulic mechanisms in CAD systems, electrical connections and connectors).
9. DFD (Design for Disassembly) - design from the point of view of disassembly (disassembly procedures, material separation, recycling, environment, energy and

water consumption). DFE (Design for Environment) - design with regard to the environment (design with regard to ecological packaging, ecological production and recycling, list and describe some standards relating to product design).

10. Design For Testability / Inspectability - design from the point of view of testing and inspection (possibility of sensor integration, types of sensors and transducers of non-electrical physical quantities, conversion of non-electrical quantities to electrical, list practical examples). Design For Trouble Free And Reliability - design from the point of view of trouble-free and reliability (testing, measurement, testing, life calculations, fatigue, wear resistance, describe what diagnostics are, failure prediction).
11. Design For Maintainability / Serviceability - design from the point of view of maintenance, repairability. (5S, maintenance of management systems according to ISO standards, state the basic principles of productive maintenance). Design for Transportation and Packaging - design from the point of view of transportation and packaging (packaging methods, packaging materials and equipment, state practical examples).
12. Design For Upgrade - design from the point of view of improvement, expansion (what are the possibilities of expanding the functions of products and their properties, where they are used, state practical examples). Design For Installability - design from the point of view of assembly, installability (installation of machines and products in their intended places, supplied energy). Design For Safeness And Guarantee - design from the point of view of safety and guarantee (state the principles).
13. Dependence of dimensional, geometric tolerances and surface roughness, RPS points. Precision of engineering production, methods and possibilities of measurement on products and marking on drawings. Tolerance analysis, drawing documentation. Gaussian curve equation, influence of individual parameters on its shape. Production settings, minimization of scrap.
14. Product optimization, procedure for creating and evaluating solutions using other methods without using FEM. Possibilities of creating control elements in the part tree, assemblies, topological optimization.
15. Calculations of static, modal analysis, natural vibrations, natural vibrations with boundary conditions, dynamic loading (state the procedure for FEM calculations, boundary conditions, loading, results, evaluation). Calculations of service life, fatigue and notches of components, probability classically and in FEM. Haigh diagram, static and dynamic stress, Wohler curve - use in product design. Difference between classical solution and FEM.

C. „TECHNOLOGY“

1. Structural materials (division, aspects for the selection of materials, principles for their inclusion in the design documentation, material standards).

2. Steels (relationship between chemical composition and properties, characteristics and principles for the selection of steel, current trends in the development of steels of common qualities and high-grade steels, steels with special physical properties). Cast irons (influence of composition, wall thickness and metallurgy on the structure and properties - description).
3. Surface treatments of materials (division, characteristics and examples of use, degree of increase in useful properties - description).
4. Light metals (Al, Mg and Li) and their alloys, non-ferrous metals and their alloys (properties and design applications).
5. Plastics (properties and design applications). Composite materials (properties and design applications).
6. Additive technologies – definition, advantages and disadvantages compared to other manufacturing technologies, additive manufacturing options from the perspective of design, materials, quality, etc.
7. Overview of additive technologies – classification of additive technologies, options and differences of individual methods, suitability for use.
8. Overview of the most important methods of additive technologies based on 3D printing from liquid photopolymers – principles of 3D printing, basic properties of printed parts, uniqueness of technologies, possibilities of use.
9. Overview of the most important methods of additive technologies based on 3D printing from powders – principles of 3D printing, basic properties of printed parts, uniqueness of technologies, possibilities of use.
10. Overview of the most important methods of additive technologies based on 3D printing from solid-state materials – principles of 3D printing, basic properties of printed parts, uniqueness of technologies, possibilities of use. Hybrid technologies – overview of technologies combining additive manufacturing with machining, advantages and disadvantages, description of the basic methods used.
11. Lean manufacturing principles (definition and examples of types of waste, definition of KANBAN management system – types of Kanban, calculation of size and number of Kanban, definition and examples of JIT/JIS usage, TPM – types of tools). Process indicators and their calculation (definition, variables and method of determining KPI indicators - OEE, continuous production time, flow, WIP, BTS, VA-index, FTT/FPI, etc.).
12. Tools for analysis of production systems (definition, method and steps of calculation, visualization, evaluation Process diagrams, Sankey and Spagetti diagram, Pareto, ABC and XYZ analysis, etc.), value stream mapping (VSM).
13. Lean production optimization tools (Poka-Yoke - definition, types and examples, 5S - definition and description of method steps, SMED - definition and description of method steps, KAIZEN - tools and continuous improvement procedure, etc.).
14. Standardization of human work and ergonomics (listing tools and definition of procedure for individual methods - methods of measuring labor consumption, MTM

and MOST predetermined time systems, basic ergonomic rules in the workplace, methods for ergonomic screening).

15. SixSigma management tools (description of the DMAIC method and the methods resulting from it, description of individual steps and tools used in these steps, analysis of the suitability of the application according to the type of project).

D. „PROJECT MANAGEMENT“

1. Introduction to project management - definition of the project, the three imperatives, the project life cycle and phases, project management in organizations with different types of management, project interest groups, project manager competencies – description.
2. Project initiation - setting SMART goals, project charter - description, Logical Framework Matrix (LRM) - explanation of the purpose, procedure for compiling the matrix.
3. Project risk analysis - explanation of the purpose, procedure for performing the analysis.
4. Methods for valuing the value and return of the project - project payback period, discounted cash flows, net present value, internal rate of return, project profitability - presentation of the relationships for calculation.
5. Project planning - WBS work structure, methods for determining task duration, time planning methods (network charts, Gantt chart, milestone chart), responsibility matrix, network analysis methods - critical path method (CMP) - principle, procedure for compiling.
6. Value created analysis (EVA) - principle, drawing S-curves, calculating deviations and costs.
7. Technical communication – definition of the term technical communication (means, principles, methods of implementation), basic assumptions of technical communication – creators (e-data, their creation and use), communication skills – main categories (brief characteristics of each area), security elements of technical communication.
8. Plan-Do-Check-Akt approach – (explain the principle).
9. Artificial intelligence – definition (methods of implementation, characteristic features, virtual reality).
10. Introduction and description of the roles of individual classes (MRP I, MRP II, ERP, APS, SCM, MES, WMS) of information systems in production planning and control, description of their primary functions and examples of application to solve specific problems in practice. Structural bill of materials (description of the meaning of the document for production planning, its functions and items).
11. Master production plan and Time schedule (steps in creating MRP I and MPS, required input and provided output information, suitability of application according to types of production system). Inventory planning methods (definition of inventory

classification, description of inventory management models, methods of determining order quantities, including their calculation based on these models).

12. Structure of production and non-production times (description of the Czech and REFA standards, including definitions of times, method of obtaining them, and their mutual relationships).
13. Determination of the size of the minimum and optimal production batch (definition of variables and coefficients, calculation of the minimum batch, method of determining the optimal batch based on constraints).
14. Method of determining the capacity balance of workplaces (definition and calculation of time requirements, definition and calculation of available capacity, definition and calculation of machine utilization).
15. Production management tools (definition and explanation of production management principles - pressure, pull, theory of constraints or TOC) and assessment of the suitability of their application with regard to the parameters of the production system (according to seriality, technology, trajectory through the production system, etc.).

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