EUROPEAN UNION
European Structural and Investment Funds
Operational Programme Research,
Development and Education

MINISTRY OF EDUCATION,
YOUTH AND SPORTS

ESF II project of the University of West Bohemia in Pilsen

reg. č. CZ.02.2.69/0.0/0.0/18_056/0013239

ETP1 - course exam questions

1. Determine the amount of heat required to heat 1 kg of ice from -10 °C to 10 °C.
2. What methods of heat transfer do you know? For each method, give an equation for calculating the heat flux.
3. State the relationship for calculating thermal conductivity and refer to its dimension.
4. What material properties are used in tool clamping, i.e. hot pressing. State the proper relation for calculating this property.
5. Which two methods of converting electrical energy into proper heat have the theoretically highest electrical energy density?
6. What is the principal difference between direct and indirect resistance heating? Which heating parameter can be easily influenced has a significant effect on both types of heating? State the relevant relationship.
7. For a non-magnetic material, e.g. Cu, how will the total R of the charge (heated material) change as a function of temperature? Plot its progress as a function of T on a graph.
8. How will the total R of the charge (heated material) vary with temperature for a magnetic material, e.g. steel? Plot the graph of this as a function of T.
9. What are the basic requirements for heating elements?
10. List 3 types of heating elements used.
11. Which heating methods have greater efficiency, indirect resistance or induction and why?
12. What is the purpose of the surface hardening of materials?
13. How do you approximately determine the power transferred to the workpiece when heated by induction?
14. Does the choice of frequency affect the power transferred to the die? If so, what is it?
15. What are the typical magnitudes of currents and voltages during inductive surface hardening on a high-frequency transformer's primary and secondary sides?
16. How will this affect its inductance if I increase the gap between the turns of an empty inductor?
17. How will this affect its inductance if I increase the number of turns of an empty inductor?
18. If I increase the diameter of an empty inductor, how will this affect its inductance?
19. If I increase the length of the pins of an empty inductor, how will this affect its inductance?
20. What effect does the gap between the inductor and the load have on the R and L measured on the inductor?
21. Explain the cold cup principle using the current density vectors in the inductor, the cold cup tube and the insertion tube.
22. How do you approximately determine the power transferred to the dielectric heating of the dielectric?
23. What common phenomenon accompanies induction and dielectric or microwave heating?
24. On what principle is dielectric heating based?
25. Which materials are suitable to be heated using dielectric heating?
26. What is the principle of a magnetron?
27. By what relation do you determine the wavelength of microwave heating?
28. What kind of waves are generated inside the cavity resonator of a microwave oven?
29. Is there any justification for the frequency chosen for microwave heating of food? If so, what is it?
30. Explain the principle of DC arc generation.
31. How does the resistance of an arc vary with its temperature?
32. What is the usual electrode material for arc heating, and what environment does the electric arc burn?
33. Describe the principle of a plasma torch.

34. What are the basic types of plasma torches, and how do they differ?
35. What are some ways to help stabilise the arc during plasma heating and reduce local loading?
36. What are the principle of electron heating and its essential structural components?
37. What depth of influence on the heated material is typically achieved in laser and electron heating?
38. Explain the principle of the ruby laser.
39. Which material parameter is proportional to the penetration depth of the laser beam into the material being heated, and which materials are therefore better heated?
40. In what wavelength range do lasers typically operate?
41. Which diagram governs heating and which governs cooling when quenching materials? How are the critical temperature points marked?
42. Does water temperature affect the cooling ability of a charge during induction heating? If so, what is it?
43. What other phenomenon accompanies surface hardening of materials except for a change in surface strength.
44. Does the initial hardening of hardened steel affect its final hardness after the surface induction hardening process?
45. What is the fundamental difficulty in numerical modelling of ferromagnetic materials?
46. Is there any connection between the ability of a surface to emit and absorb infrared radiation?
47. What do we call a body with the best ability to absorb infrared radiation in terms of its surface design?
48. What do we refer to as a body with the best ability to emit infrared radiation in its surface design?
49. Draw in one graph the approximate radiation curves of a black body for three arbitrary different temperatures.
50. What relationship can be used to determine at which wavelength a body radiates through its surface with the greatest intensity?
51. Is there a continuity between the thermal and electrical conductivity limits? LT=λ/γ , L=λ/ γT=2.45∗10^(-8) [〖WΩK〗^(-2)]
52. For most electrically conductive materials, how does their thermal conductivity change as a function of temperature?
53. State the Fourier-Kirchoff equation for a plain wall with no internal heat sources at a steady-state?
54. How would you characterise the steady-state?
55. Can any analogies with electrical quantities be used in thermal calculations? If so, please indicate how.
56. What is the character of the curve defining the temperature through a plane wall in the steady-state?
57. For a 1D planar wall with no internal heat sources, will the magnitude of its heat flux change as a coordinate function in the steady-state?
58. Express a general relationship for the heat flux through a 1D plane wall.
59. Express the relationship for the heat flux through a 1D composite wall of 3 distinct layers.
60. What is an isotherm?
61. What is the Leidenfrost effect?
62. What is membrane boiling, and how does it affect the cooling of deposits heated well above boiling point?
63. Plot on a single graph the typical pattern of losses by flow and radiation as a function of the body's surface temperature.
64. State the heat transfer coefficient by flow and the five parameters that affect its magnitude.
65. How do we classify flow according to its origin and mode of transmission?
66. What should a tubular heat exchanger design look like to achieve high efficiency?
67. What is the Coanda effect?
68. What is the principle of a ventilation system equipped with heat recovery?

69. In principle, what happens when infrared radiation strikes a surface?
70. Can the amount of energy absorbed by a body when heated by infrared radiation be influenced in any way?
71. How is the air in a room heated by radiant panels heated?
72. In what wavelength range are electromagnetic waves referred to as infrared?
73. What is the difference between thermal and infrared radiation?
74. Draw in one graph what the temperature distribution of a room looks like depending on which source is used to heat it, in the case of hot air heating and the possibility of radiant heating—vertical axis height horizontal axis temperature.
75. What would you do if you were to determine the sun's surface temperature? (wavelength of about $0.5m$ for the yellow-green case)
76. State the 1st Maxwell's equation and explain its meaning.
77. State the 2nd Maxwell's equation and explain its meaning.
78. State the 3rd Maxwell's equation and explain its meaning.
79. State the 4th Maxwell's equation and explain its meaning.
80. Draw the vectors H and J orientation for two parallel plane walls, one representing the inductor and the other the insertion. Start from the direction of orientation of the current density in the inductor, which you choose arbitrarily.
81. List all three material relationships that hold between the EMF quantities.
82. Where did the depth of penetration come from? Just describe verbally.
83. At what distance from the edge of an inductively heated planar wall will H and E attenuate to zero essentially?
84. What is the condition for determining whether the heated induction wall is of small or large thickness?
85. Plot the waveforms of H and J for a 1D wall of small thickness, absolute values only, versus X.
86. Plot the waveforms of H, J, and σ for a 1D wall of large thickness, absolute values only, versus X.
87. Plot the ρ waveform for a typical electrically conducting material versus temperature.
88. Plot the waveform of μr for a typical electrically conducting and non-magnetic material versus temperature.
89. Plot μr for a typical electrically conducting and magnetic material versus temperature.
90. Use the figure to explain the difference between longitudinal and transverse electromagnetic fields.
91. Use the figure to explain the principle of shielding inductive devices by a conducting wall.
92. With the help of the figure, explain the principle of shielding of inductive devices through transformer plates. In particular, indicate their orientation concerning the inductor.
93. Using the figure, explain the principle of shielding inductive devices by ferrite.
94. What is the appropriate boundary condition to choose when calculating the electromagnetic field in the axis of symmetry of a cylindrical conductor flowing through a current and why?
95. When calculating the electromagnetic field in the axis of symmetry of an inductively heated cylindrical charge, what is an appropriate boundary condition and why?
96. Draw the possible waveform of H, J and $$sigma$ in a cylindrical conductor flowing with alternating current.
97. Draw the waveform of H, J and σ in a cylindrical inductively heated charge.
98. What is the relationship between energy and power?
99. In what way are power components and induction devices usually cooled?
100. Under what conditions does electromagnetic transparency occur?
101. What should be the thickness of a strip conductor to minimise its Joule losses?

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