Module name: **Electrical Circuits 2**
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Class 8 (30.04.2024)

1. In a 3-phase unbalanced Y-Y system, the source voltage is E_{ph} = 230 V rms. The load impedances are: $\underline{Z}_A$ = (6+j8) Ω, $\underline{Z}_B$ = (8+j6) Ω, $\underline{Z}_C$ = 20 Ω. What should be the rated current of the overcurrent circuit breakers protecting this circuit? Standard rated currents are: 6 A, 10 A, 16 A, 20 A, 25 A, 32 A, 40 A, 50 A, 63 A, 80 A, 125 A. What is the cost of active energy used by this load during one week (8h per day, 5 days, 0.289 €/kWh)? Consider two cases: a) without a neutral wire, b) with a neutral wire. Draw phasor diagrams of currents and voltages for both cases.

2. A balanced 3-phase distribution line is used to supply three balanced Y-loads that are connected in parallel:

   Load 1: 37 kVA at 0.72 power factor, lagging
   Load 2: 64 kVA at 0.83 power factor, leading
   Load 3: 55 kW and 29 kVAr.

   The line voltage at the load is 660 V rms. Find the line current in the distribution line and the combined power factor (pf) at the load.

3. A 3-phase electric heater with nominal power P_n = 15 kW is used to heat the warehouse. The heater is supplied from a power network with a phase voltage of U_n = 230 V. The heating elements are Δ-connected. The heater operates at full power for 12 hours a day. A photovoltaic installation has been installed in close proximity to the warehouse, which has caused the phase voltage increase from U_n = 230 V to U_n' = 242 V. Calculate the percentage increase in warehouse heating costs in one day due to the increase in phase voltage.

4. In the room, there is a three-phase electric motor supplied from a power network with a voltage of U_n = 230/400 V. The motor windings are Δ-connected. The motor parameters are: nominal power P_1 = 15 kW, motor efficiency η_1 = 0.895, power factor $\cos\varphi_1$ = 0.9. It was decided to install a second three-phase motor in the same room with the parameters: P_2 = 7.5 kW, η_2 = 0.88, $\cos\varphi_2$ = 0.88. The room is supplied with power by a copper wire 5×6 mm^2. Check whether, after installing the second motor, the cable cross-section will be sufficient due to its long-term current carrying capacity. In the case of 5-core copper conductors laid in the room, the long-term current carrying capacities are: 1.5 mm^2 - 17 A, 2.5 mm^2 - 24 A, 4 mm^2 - 31 A, 6 mm^2 - 40 A, 10 mm^2 - 55 A.

5. In a balanced Y-Δ three phase system, the source line voltage is 330 V rms. The impedance per phase of the load is $\underline{Z}_{load}$ = (30+j27) Ω. The line impedance is $\underline{Z}_{line}$ = (2+j3) Ω. Find the annual cost of energy losses in this line (300 days, 10 hours/day, 0.289 €/kWh)

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