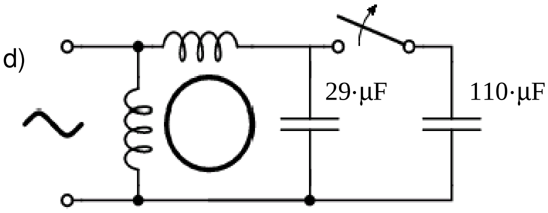
ECE 3600 Exam 3 given: Spring 24

DO NOT use erasable ink

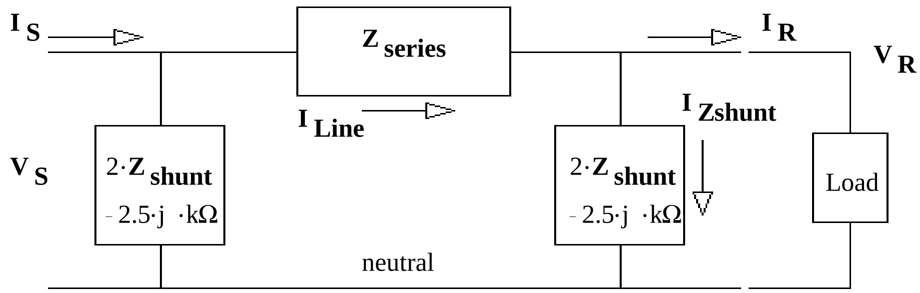
Answers

1. a) $140\cdot\mu F$ b) $29\cdot\mu F$ c) $2.35\cdot A\ \angle 0^\circ$ d)



2. a) $1.885\cdot\Omega$ b) $287\cdot W$ c) $65\cdot\%$ d) $2.34\cdot A$
   e) $1424\cdot rpm$ f) $895\cdot W$ g) $23.2\cdot A$ h) No I_A too high

3. a)



b) i) c) $233.5\cdot A\ \angle 18.2^\circ$

d) $569\cdot\Omega\ \angle -18.2^\circ$

e) $255.1\cdot A\ \angle 29.6^\circ$

f) $109\cdot\Omega\ \angle 66.4^\circ$

g) $(\underbrace{0.218}_{r} + \underbrace{0.499\cdot j}_{x})\cdot\frac{\Omega}{km}$

h) $96.86\cdot MW$ i) $91.2\cdot\%$

1. (30 pts)A 1/3-hp, 120-V, 60-Hz, single-phase, capacitor-run, single-phase induction motor has two identical windings set 90º apart in the motor housing. Each winding draws $7A$ at $64°$ lag when the rotor is locked. This is with no added capacitors, so the motor would have to be started by hand.

   a) Find the ideal capacitor to place in series with one of the windings at **startup**.
   Note: the ideal capacitor would create the ideal phase difference between the winding currents.

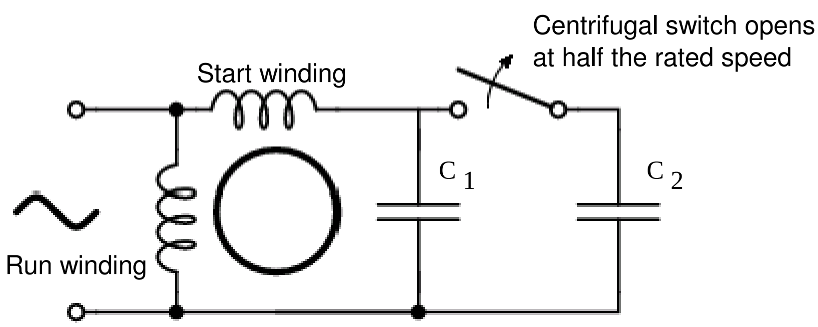
More room on next page ===>

b) Each winding uses 141W at pf = 0.85 when the motor is running at its rated speed. This is with no added capacitors, so the motor would have to be started by hand. Find a different capacitor to replace the capacitor of part a). Choose this capacitor to make the current magnitude in the two windings exactly the same at rated speed. (Don't worry about the phase angles.)

$V_S := 120 \cdot V \qquad P_r := 141 \cdot W \qquad pf_r := 0.85$

c) Find the input current (sum of both) magnitude and phase at rated speed with the capacitor of part b) in place.

d) If the motor had a centrifugal switch which opens at half the rated speed, devise a design to achieve the conditions of parts a) and b). Find all capacitor values needed.



2. (35 pts) A separately excited dc motor is rated at 2-hp, 1200rpm, armature: 150 V 14.5A, field: 150 V 0.8A. **Exam 3 Sp 24 p3**

a) The field is connected to the rated voltage and then you spin this motor with another device at 900rpm. The dc motor is connected to a voltmeter and nothing else. You measure the terminal voltage at 92 V . Find R_A from this information and the ratings.

$1 \cdot hp = 745.7 \cdot W$

$V_{Tr} := 150 \cdot V \qquad n_{fL} := 1200 \cdot rpm \qquad I_{AfL} := 14.5 \cdot A$

If you can't find R_A , mark an X here ______ and use 2Ω for the rest of the problem.

Unless stated otherwise, assume rated voltages below.

b) Find the rotational losses at when operated at full load. $P_{rot} = ?$

c) Find the overall efficiency (includes power needed for the field) when operated at full load.

d) Find the no-load armature current. Show the algebra needed to find I_A from the basic equations. The rotational losses are proportional to the motor speed.
Hint 1: This also means that the rotational losses are proportional to E_A, like this: $P_{rot2} = P_{rot1} \cdot \frac{E_{A2}}{E_{A1}}$
Hint 2: This turns out to be amazingly easy to calculate, no quadratic required.

e) Find the no-load shaft speed.

f) The mechanical load on the shaft is increased and the motor slows down to: $n_{new} := 1300 \cdot rpm$

Find the load power at this speed.

The field voltage is reduced to 120V and the armature is left at the rated voltage.
The load is then adjusted so that the speed is again 1300rpm.

g) Find the armature current at this field voltage.

h) Would it be OK to operate this way for a long time?

_____ / 35

3. (35 pts) A 230 kV (nominal) transmission line has the following length and line parameters. $S := \text{siemens}$

$len := 200 \cdot km$ $r = ?$ $x = ?$ (will be found in problem) $g := 0 \cdot \frac{S}{km}$ $y := 4 \cdot 10^{-6} \cdot j \cdot \frac{S}{km}$

a) Choose the most appropriate model for this transmission line and draw it, including the impedance and/or admittance value(s) you can find at this time. Add a 3ϕ load at the receiving end of the transmission line.

The line voltage at both the sending **and** the recieving end are **both 230kV**. The power angle is 12º. $\delta := 12 \cdot deg$

The load at the recieving end is $S_R := 93 \cdot MVA$ It's power factor is 0.95.

b) Judging by the voltages, the load power factor is most likely: i) leading ii) lagging (circle one)

c) Find the line current to the **load**, $\mathbf{I_R}$ (not $\mathbf{I_{Line}}$) as a complex number.
Clearly state what you are using as the 0º reference.

d) Find the impedance of one phase of the load, assuming Y-connected.

More on next page ===>

e) Find the line current in your model, $\mathbf{I}_{\mathbf{Line}}$ (not $\mathbf{I}_{\mathbf{S}}$) in a complex-number form. $\mathbf{I}_{\mathbf{Line}}$ = ?

f) Find the series impedance of the line. $\mathbf{Z}_{\mathbf{series}}$ =?

If your answer to for $\mathbf{Z}_{\mathbf{series}}$ comes out unreasonable, go back and rethink your answer to part b).
Rework your other answers as necessary.

g) Find the missing line parameters. r = ? x = ?

h) How much real power does the source supply?

i) What is the effiency of this line?

_____ / 35

Total ________/ 100