EEL102 Principles of Electrical Engineering
Major exam

Maximum time: 2 hrs   **Maximum marks: 35**

<u>Instructions</u>
Answer all parts of the question together. Partial credit will be given for questions 7, 9, 10, and 12 only.

1. Which statement is *incorrect* about phasors?
    a. They are stationary vectors representing ac quantities
    b. They can be associated with sinusoidally varying quantities only
    c. The relative angle between two phasors remains constant under steady state conditions
    d. The instantaneous value of a phasor is not defined
                                                                          [1.5]

2. A 6-pole, 50Hz, 3Φ induction motor has a full load speed of 950rpm. The speed at half load is
    a. 500rpm   b. 475rpm   c. 975rpm   d. 1000rpm
                                                                          [1.5]

3. When the load is removed, the following machine will run at the highest speed
    a. dc shunt motor
    b. induction motor
    c. synchronous motor
    d. dc series motor
                                                                          [1.5]

4. The following rotor quantity in a squirrel cage induction motor does not depend on the slip
    a. rotor frequency
    b. rotor reactance
    c. rotor resistance
    d. rotor induced emf
                                                                          [1.5]

5. A dc shunt generator supplies a 7.5kW load at 200V. The armature and field resistances are 0.6Ω and 80Ω respectively. The generated emf is
    a. 224V   b. 448V   c. 123.5V   d. 202V
                                                                          [1.5]

6. In a dc machine, the following is *always* true
    a. pole flux varies linearly with speed of the machine
    b. induced emf varies linearly with pole flux
    c. pole flux varies linearly with field current
    d. armature current varies linearly with field current
                                                                          [1.5]

7. The primary winding resistance and reactance of a 230/460 V transformer are 0.2Ω and 0.5Ω respectively. The corresponding values of the secondary winding are 0.75Ω and 1.8Ω respectively. Find the secondary terminal voltage when supplying a 10A load at 0.8pf lagging.
                                                                          [5]

8. The primary and secondary winding of an auto-transformer are rated at 400V and 500V respectively. With the help of a diagram, show the current distribution in the winding, when the secondary current is 100A.
                                                                          [3]

9. Assuming that the electric breakdown voltage of air is 30kV/cm and the maximum magnetic flux density tolerated is 1T, compare the maximum energy that can be stored by electric and magnetic fields.
   [4]

10. A tungsten filament bulb, rated at 100V, 500W, is to be connected in series with a capacitance across a 200V, 50Hz supply. Treat the bulb as a pure resistance.
    a. Draw the phasor diagram of the circuit, selecting the correct reference.
       [2.5]
    b. Calculate the value of the capacitance such that the voltage across and power consumed by the bulb are at their rated values.
       [2.5]
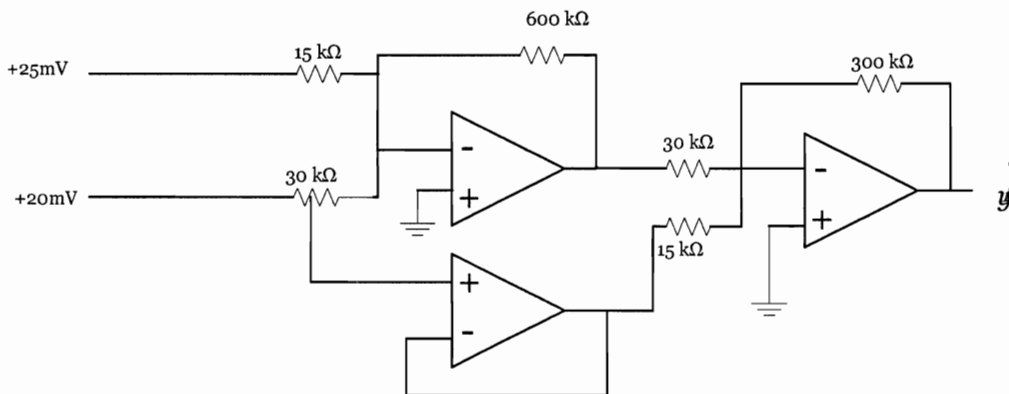11. Draw the output of the following circuit to a sinusoidal input. Assume ideal diode.
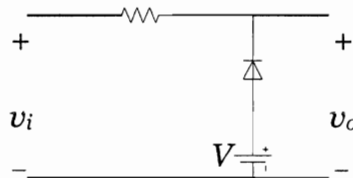
       [2]
12. Consider a *two-phase* induction motor, with the two phase windings displaced in space by 90°. The supply consists of two phases with 90° phase displacement. What is the nature of the magnetic field in the air gap?
    [4]

13. Calculate y in the following circuit

    [3]

Extra Credit (No partial credit)

14. One effective way of compensating for armature reaction in dc machines (and thereby reduce sparking at the commutator brushes) is to have additional *interpole* windings, located the interpolar region between the main poles. Which circuit is this winding connected and how?
    a. shunt across the armature
    b. series with the armature
    c. shunt across the field
    d. series with the field
    [2]
15. The wattmeters used in the EEL102 experiments have an associated multiplying factor, that can be modified by altering the connections between B1,B2 and E1,E2 terminals. Altering these connections actually change the rating of the current coil. What exactly is happening inside the instrument, when you change these connections?
    [3]