BITS, PILANI – DUBAI CAMPUS,
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
SECOND SEMESTER 2011 – 2012
ES C272 ELECTRICAL SCIENCES II
COMPREHENSIVE EXAMINATION (CLOSED BOOK)

MAXIMUM MARKS: 120 **WEIGHTAGE: 40%**
DATE: 05.06.2012 **DURATION: 3 HOURS**

NOTE: 1) Attempt all parts of a question sequentially. 2) If a question is answered twice and not cancelled, only the first attempt will be evaluated. 3) Show calculations stepwise. 4) Sketches/ diagrams are to be complete.

PART A

1) For the circuit shown in Figure 1, determine the value of total applied voltage (V) and the circuit power factor **[15 marks]**

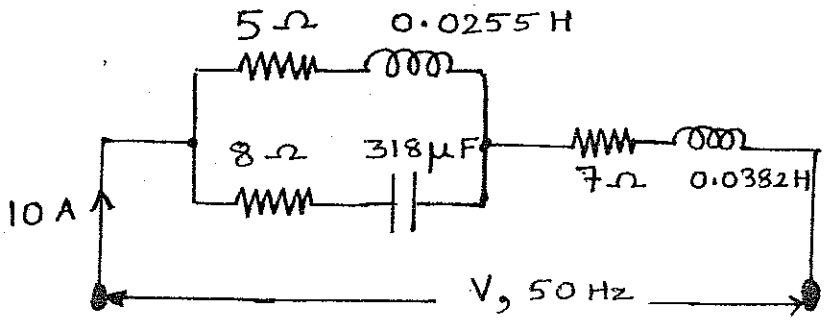

Figure 1

2) Consider the unbalanced delta connected load shown in Figure 2.Find the Line Currents. Phase sequence 'abc' **[15 marks]**

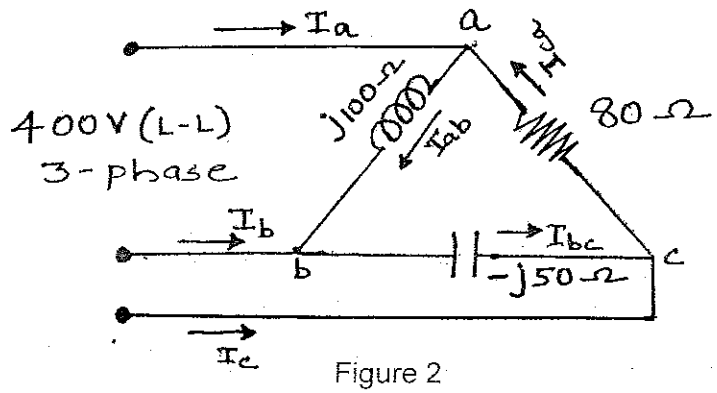

Figure 2

3) A capacitor and resistor are connected in series across a 120V; 50 Hz supply. The circuit draws a current of 1.144 Amperes. If the power loss in the circuit is 130.8 Watts, find the values of resistance and capacitance. **[10 marks]**

PART B

4) The magnetic circuit of Figure 3 has a cast steel core with dimensions as shown. The area of cross section of the central as well as each outer limb is 16 cm^2. Determine the current in the 500 turn exciting coil to establish a flux of 0.5 mWb in the air gap, if the relative permeability of the core material is
(i)4000 (ii) Infinity

Note: Maintain a minimum of four decimal accuracy in all steps. **[20 marks]**

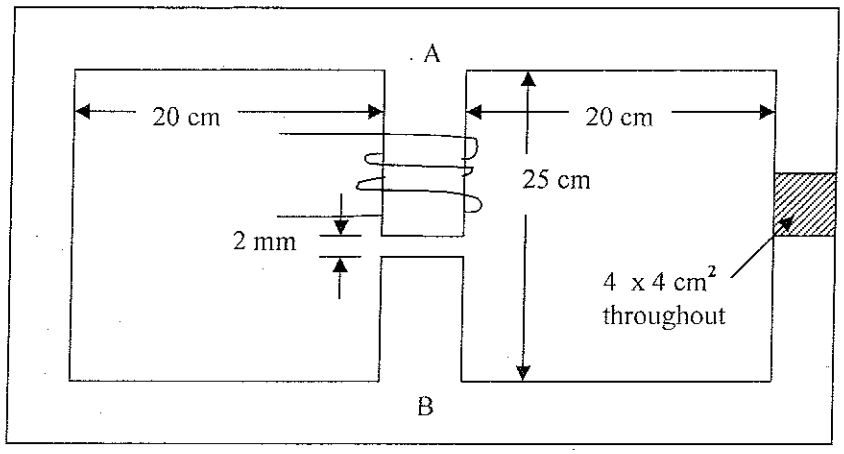

Figure 3

5) The resistances and leakage reactance's of a 10KVA, 50 Hz, 2300/230V distribution transformer are r_1 = 3.96 Ω and r_2 = 0.0396 Ω, x_1 = 15.8 Ω and x_2 = 0.158Ω; subscript 1 refers to HV side and 2 to LV side winding.

(a) The transformer delivers rated KVA at 0.8 pf lagging to a load on the LV side. Find the HV side voltage necessary to maintain 230V across load terminals. Also find the percentage voltage regulation.
(b) If a capacitor bank is connected across the load, what should be the KVA capacity of the bank to reduce the voltage regulation to zero? What should be the HV side voltage necessary under these circumstances

[20marks]

PART C

6) A 10 kW, 250 V dc shunt motor has armature resistance of 0.5 Ω and a field resistance of 200 Ω. At no- load and rated voltage, the speed is 1200 rpm and the armature current is 3A. At full-load and rated voltage, the line current is 47A and because of armature reaction, the flux is 4% less than its no-load value. Determine the following at full load condition:
(a) Speed.
(b) Torque developed
(c) Gross mechanical power developed
(d) Armature copper loss
(e) Electrical input **[15 marks]**

7) The following data are taken from the open-circuit and short-circuit characteristics of a 45-kVA, three-phase, Y-connected, 220-V (line-to-line), six-pole, 60-Hz synchronous generator.
From the open-circuit characteristic:
Line-to-line voltage = 220 V Field current = 2.84 A
From the short-circuit characteristic:

Armature current (A)	118	152
Field current (A)	2.20	2.84

From the air-gap line:
Field current = 2.20 A Line-to-line voltage = 202 V

Determine
(a) The speed of rotation
(b) The unsaturated synchronous reactance
(c) The adjusted synchronous reactance
(d) The excitation voltage needed to give rated voltage at full load, 0.8 pf lagging. Use adjusted synchronous reactance.
(e) Voltage regulation for load specified in (d). **[20 marks]**

8) A 4-pole, 3-phase induction motor operates from a supply whose frequency is 50 Hz and is running at a slip of 4%. Calculate the following:
(a) Motor speed
(b) Frequency of rotor emf **[5 marks]**

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TEST 2(OPEN BOOK)

MAXIMUM MARKS: 60 **WEIGHTAGE: 20%**
DATE: 22/04/12 **DURATION: 50 MINUTES**

1) An 8 kVA, 400/120 V, 50 Hz, single phase transformer gave the following test results:

OC test: (on LV side): 120V, 4A, 75W
SC test: (on HV side): 9.5 V, 20 A, 110 W

1. a) Draw the circuit model of the transformer with reference to HV side.
1. b) Draw the circuit model of the transformer with reference to LV side.
1. c) Determine the load power factor for zero voltage regulation when the transformer is fully loaded.

(Note: For 1.a and 1.b, your answers must be in Ω, mΩ or their reciprocals.)

[20 marks]

2) A ring of magnetic material has rectangular cross section. The inner diameter of the ring is 15 cm and outer diameter is 25cm, its thickness being 2.5 cm. An air-gap of 2 mm length is cut across the ring. The ring is wound with 1500 turns carrying current of 2A. The permeability of the magnetic material 5000. Find the following

(i) Flux density in the air-gap
(ii) Inductance of the coil
(iii) Energy stored in the magnetic material.

[20 marks]

3) A balanced three phase load consisting of three coils is supplied by a balanced three phase 400 V supply. Determine the line current, real and reactive power absorbed by the coils when :

(i) Star connected with (6+j8) Ω/phase.
(ii) Delta connected with (3+j2.5) Ω/phase.

Draw the vector diagram of the system for the above two connections.

[20 marks]

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TEST 1(CLOSED BOOK)

MAXIMUM MARKS: 75 **WEIGHTAGE: 25%**
DATE: 08/03/12 **DURATION: 50 MINUTES**

1. A full-wave rectified sinusoidal voltage is clipped at $1/\sqrt{2}$ of its maximum value as shown in Figure.1. The wave is described by the equation $v=V_m \sin\omega t$ volts. Calculate (i) Average Value. (ii) RMS value of such a voltage.

[25 marks]

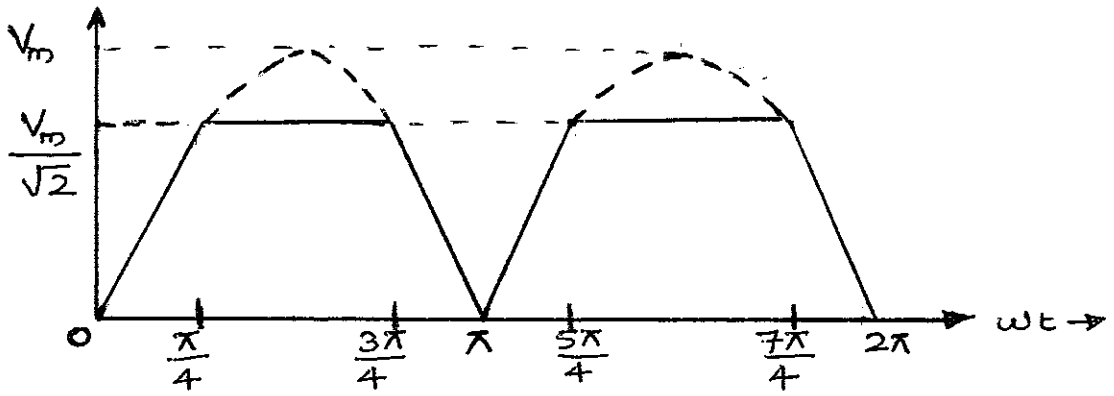

Figure 1

2. For the series RLC circuit shown in Figure 2, Find
   a) Frequency in Hertz.
   b) Inductive and Capacitive reactance.
   c) Driving point impedance and admittance.
   d) Phasor voltage and current.
   e) Real and Reactive power supplied by the source. **[25 marks]**

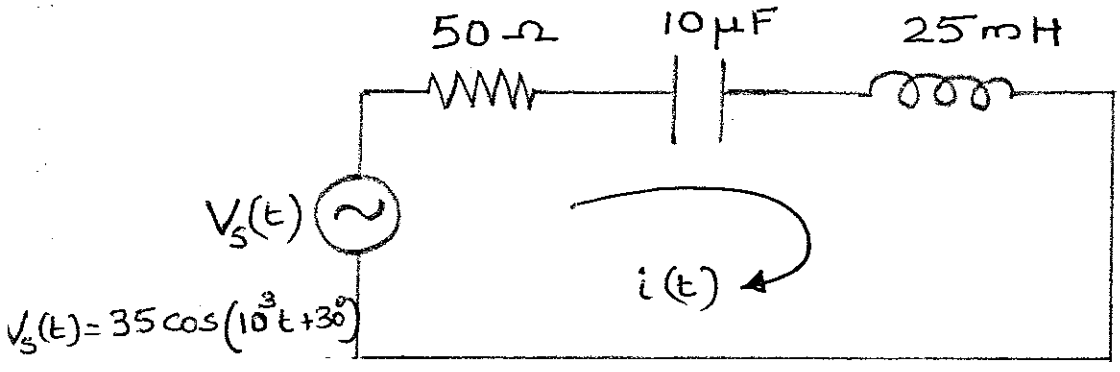

Figure 2

3. A 10KVA load at 0.8 power factor lagging is fed from 230 Volts, 50Hz, single phase supply. Calculate the KVA capacity and the capacitance value of the shunt capacitor required to improve the overall power factor (load + shunt capacitor) to 0.9 lagging. Compare the current drawn from the supply before and after installing the capacitor. **[25 marks]**

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QUIZ 2 (CLOSED BOOK)

MAXIMUM MARKS: 21 | **SET 1** | **WEIGHTAGE: 7 %**
DATE: 14.05.12 | **DURATION: 20 MINUTES**

NAME: **Id. No.:**

1. If a transformer primary is energized from a square wave voltage source, its output voltage will be

(A) A square wave. (B) A sine wave.
(C) A triangular wave. (D) A pulse wave.

[2 Marks]

2. In a transformer the voltage regulation will be zero when it operates at

(A) unity p.f. (B) leading p.f.
(C) lagging p.f. (D) zero p.f. leading.

[2 Marks]

3. Open circuit and Short circuit tests performed on a transformer indicate _____ and _____ losses respectively. [2 Marks]

4. A 220/440 V, 50 Hz, 5 KVA, single phase transformer operates on 220V, 40Hz supply with secondary winding open circuited. Then

(A) Both eddy current and hysteresis losses decreases.

(B) Both eddy current and hysteresis losses increases.

(C) Eddy current loss remains the same but hysteresis loss increases.

(D) Eddy current loss increases but hysteresis loss remains the same. [1Mark]

5. A ring of magnetic material has rectangular cross section. The inner diameter of the ring is 20cm and the outer diameter is 30 cm, its thickness being 4cm. The mean flux path length is _____ [2 Marks]

6. A transformer operates most efficiently at full load. Its iron loss (Pi) and copper loss (Pcu) are related as:

(a) Pi/Pcu = 1 (b) Pi/Pcu = 0.75

(c) Pi/Pcu = 0.5 (d) Pi/Pcu = 1.5 [2 Marks]

7. Magnetic cores ideally should have _____.

(a) Large permeability (b) Small permeability

(c) Zero permeability (d) None of the above. [1Mark]

8. The energy stored in an ideal Transformer is _____ [1Mark]

9. The flux (in Webber) in a closed circuit of resistance10 Ω is given by the expression:

$\Phi=6t^2+5t+2$.

The induced current at t= 1 second is _____ [4 Marks]

10. Two coils of inductances L_1 and L_2 are placed close such that magnetic flux in one coil completely links the other. The mathematical expression for mutual inductance between the coils is _____ [2 Marks]

11. Permeability in a magnetic circuit is analogues to _____ in an electric circuit. [1Mark]

12. The unit of magnetic Reluctance is _____ [1Mark]

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QUIZ 1 (CLOSED BOOK)

MAXIMUM MARKS: 24 | **SET 1** | **WEIGHTAGE: 8 %**
DATE: 26.03.12 | **DURATION: 20 MINUTES**

NAME: **Id. No.:**

1. The KVA of an ac circuit having KW =80 and KVAR =60 is_____. [2 Marks]

2. The RMS value of a sinusoidal alternating current is _____ times its maximum value. [2 Marks]

3. A coil has X_L = 1000 ohms, if both its inductance and frequency are doubled its reactance will become _____. [2 Marks]

4. To improve the power factor of the power system network _____ are installed. [1Mark]

5. In a series circuit with R=10 Ω, X_L = 45 Ω, X_C = 35 Ω and carrying an effective current of 5A, the real power dissipated P = _____ and reactive power Q = _____ [2 Marks]

6. The Line current in a balanced delta system is 17.3 A.What is the phase current? [1Mark]

(a) 5 A
(b) 10 A
(c) 34.6 A
(d) 17.3 A

7. The algebraic sum of the instantaneous phase voltage in a 3- phase circuit is _____. [1Mark]

8. In a single phase circuit, a wattmeter indicates 200W.The circuit current and Voltage are 3 A and 115 V. The power factor for the above circuit is _____. [1Mark]

9. When power factor of a single phase circuit is 1, the relation between real power (P) and Apparent Power (S) is _____ [2Marks]

(a) P=S (b) P= 0.5 S (c) P=2S (d) None of the above

10. The phasor (-8+j4) in polar form is _____ [1Mark]

11. The current through a 400 Ω resistor is given by the equation, $i = 0.06 \cos(\omega t - 30^\circ)$ A. The voltage across that resistor would be _____. [2Marks]

(a) $24\angle 30^\circ$ (b) $24\angle -30^\circ$ (c) $24\angle 60^\circ$ (d) $24\angle 90^\circ$

12. In an ideal inductive circuit shown in Figure.1, the r.m.s current in the circuit is 5 A. The magnitude of impedance $|Z|$ for the circuit is _____Ω. [3Marks]

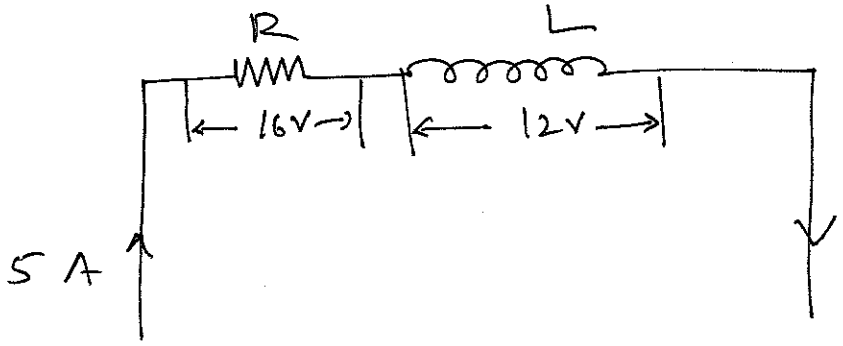

Figure.1

13. The a.c voltage and current for an ideal inductor circuit is 20 Volts and 1.8 Amperes. The Real power drawn by the circuit is _____Watts. [2Marks]

14. The voltage of an a.c mains is $v = 200\sqrt{2} \sin 100t$, where t is in seconds. The frequency of the a.c is _____ [2Marks]