**The Open University of Sri Lanka**
**Department of Electrical and Computer Engineering**
**Diploma in Technology**
**ECX3232– Electrical Power**
**Final Examination -2014/2015**
**Duration: Three hours**

**Closed book**

Date: 04th August 2015                                                                 Time: 09.30-12.30hrs

**This paper contains eight (8) questions. Answer any 5 questions. All questions carry equal marks.**

**(1)**

a) What is the benefit of reducing peak demand to the economic development of any country? **[4 Marks]**

b) What are the actions taken by utilities to reduce peak demand? **[4 Marks]**

c) A load variation throughout a day of a certain consumer metered at 400/230 V nominal, 50 Hz ac system is shown in Table Q1.

**Table Q1**

| Time | Load | Operating p.f. |
|------|------|----------------|
| 0000-0600 | 15 kW | unity |
| 0600-1000 | 35 kVA | 0.8 |
| 1000-1700 | 44 kVA | 0.9 |
| 1700-2400 | 20 kW | unity |

   i. Draw the daily load curve for this consumer and determine the load factor. **[3 Marks]**

   ii. What is the maximum demand? **[2 Marks]**

   iii. What is the applicable tariff rate of this consumer? **[1 Marks]**

   iv. Calculate the monthly electricity bill of this consumer. **[6 Marks]**

*Note: A month consists of 30 days. Tariff rates offered from the utility is given in page 4*

**(2)**

a) While performing the short circuit test for a power transformer in the laboratory, it is observed that all the associated equipments are connected to high voltage side of the particular transformer. Explain why? **[2 Marks]**

b) State the transformer losses obtained from the open circuit test and short circuit test respectively. Also explain variations of these losses with respect to load current. **[2 Marks]**

c) A 20 kVA, 2000/200 V , 50 Hz distribution transformer gave the following test results as shown in the circuit diagram:

**Test 01:**
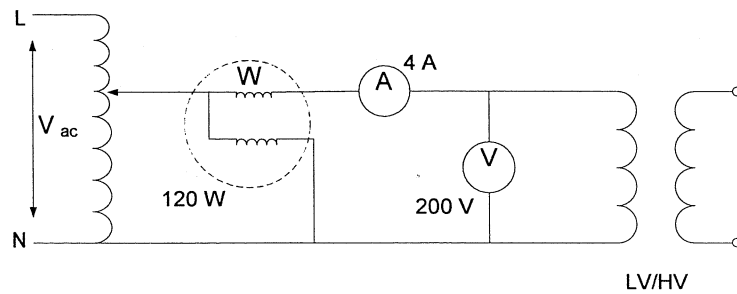


**Figure Q2(a)**

**Test 02:**
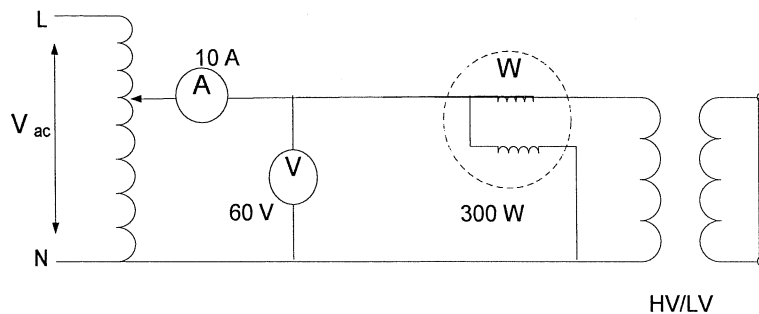


**Figure Q2(b)**

   i. Identify the two tests of the transformer, shown in FigureQ2(a) and FigureQ2(b)    **[4 Marks]**

  ii. Compute the relevant parameter and draw the equivalent circuit of the transformer referred to LV side.    **[6 Marks]**

 iii. Calculate the full load efficiency of the transformer when operating at 0.85 power factor.

                                                                                 **[3 Marks]**

  iv. At what load, the transformer should operate for maximum efficiency? Also determine the maximum efficiency at unity power factor.    **[3 Marks]**

**(3)**

  a) Briefly explain the speed-torque characteristics of a DC series motor. Assume no saturation.

                                                                                **[4 Marks]**

  b) A DC series motor connected to a 400 V supply, runs at 600 rpm when taking a current of 50 A. Calculate the value of resistance which when inserted in series with motor will reduce the speed to 400 rpm, the gross torque being then half its previous value. The total resistance of motor is 0.2 $\Omega$. Assume linear magnetization.    **[16 Marks]**

**(4)**

  a) What are the applications of DC shunt motor?    **[4 Marks]**

  b) A 60 kW, 230 V, DC shunt motor runs on no-load at a speed of 1350 rpm, drawing a current of 10 A from main supply. It has armature resistance of 0.1 $\Omega$ and field resistance of 100 $\Omega$. When delivering a certain load, the motor draws 200 A from mains. Find speed at which it runs at this load and torque developed. Assume armature reaction causes 5% reduction in flux/pole of its no-load value.

                                                                                **[16 Marks]**

a) Compare the merits and demerits of squirrel cage induction motor with wound rotor induction motor.

[4 Marks]

b) State A 3-phase, Y connected, 460 volt (line to line),60 Hz, 8 pole induction motor has the following parameters, in ohms per phase referred to the stator;

$R_1 = 0.342$ $\qquad$ $R_2 = 0.164$

$X_1 = 0.561$ $\qquad$ $X_2 = 0.265$ $\qquad$ $X_m = 14.75$

Friction + windage + stray load losses = 265 W

Using approximate equivalent circuit or otherwise, calculate the following for an operation at a slip of 0.02 by stating any assumptions made. (The motor is operated at rated voltage and frequency)

i. Rotor speed [4 Marks]

ii. Stator current and power factor [4 Marks]

iii. Output torque and power [4 Marks]

iv. Efficiency [4 Marks]

(6)

a) Compare merits and demerits of ring main distribution system with radial distribution system?

[4 Marks]

b) A 50 Hz, single phase transmission line has several loads 5 km away from the substation as shown in figure Q6. The resistance and reactance of the transmission line is 0.5 $\Omega$/km and 6 $\Omega$/km. In order to maintain 400 V at the load end ,Calculate

i. Current in the transmission line [4 Marks]

ii. Substation voltage [4 Marks]

iii. Active and reactive power dissipated in the line [4 Marks]

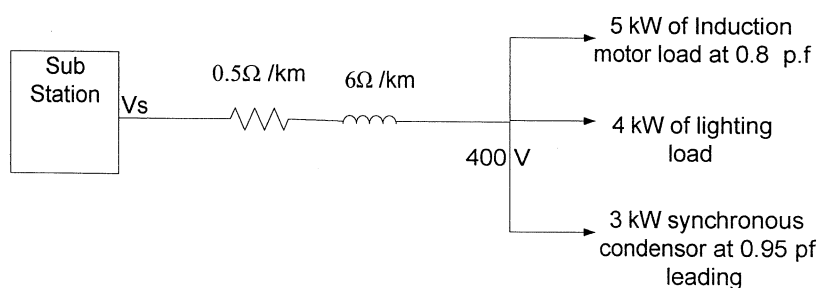iv. Active and reactive power delivered by substation [4 Marks]



**Figure Q6**

(7)

a) What types of generating stations are dispatched at peak loads? Explain your answer. [5 Marks]

b) What are the most common types of faults in domestic installation? Briefly explain how you protect your domestic installations from these faults. [5 Marks]

c) What are the merits and demerits of Fully enclosed (cartridge) fuse over Re-wirable (semi-enclosed) fuse? [5 Marks]

d) What are the advantages of inter-connected grid system? [5 Marks]

**(8)**

a) What are the effects of harmonic current on distribution transformer in a power system?  [4 Marks]

b) A coil having R=100 Ω and L=0.1 H is connected in series with a capacitor across a supply, the voltage of which is given by $e = 200\sin 314t + 5\sin 3454t$. What capacitance would be required to produce resonance with the 11<sup>th</sup> harmonic. Find

   i. The equation of the current  [8 Marks]

   ii. The rms value of the current, if this capacitance is in the circuit  [8 Marks]

## Tariff rates offered from the utility for Q#1

### Customer Category I- 1
This rate shall apply to supplies at each individual point of supply delivered and metered at 400/230 Volt nominal and where the contract demand is less than or equal to 42 kVA.

### Customer Category I- 2
This rate shall apply to supplies at each individual point of supply delivered and metered at 400/230 Volt nominal and where the contract demand exceeds 42 kVA.

| Customer Category | Energy charge (Rs/kWh) | | | Fixed Charge (Rs/ month) | Maximum Demand Charge per month (Rs/kVA) | Fuel adjustment charge (% of Energy Charge) |
|---|---|---|---|---|---|---|
| | Peak 1830-2230 hr | Off-Peak 2230-0530 hr | Day 0530-1830 hr | | | |
| Industry | | | | | | |
| I-1 | 12.50 | | | 600 | | 15 |
| I-2 | 21.00 | 7.00 | 11.30 | 3,000 | 1,100 | 15 |

Note: Fuel adjustments charge is applied only on monthly energy charge. It is not applied on monthly fixed charge and monthly demand charge