BITS PILANI K. K. BIRLA GOA CAMPUS

SEMESTER-I, 2022-2023

ELECTRICAL MACHINES (MIDSEM) EEE_ECE_INSTR F211 (Part-A)

Date-03/11/2022 Total Marks: 10×3M=30 Duration: 30 min

[Take necessary assumptions with proper justifications whenever required]

[Write your answers up to four decimal places]

1. The efficiency of a single phase, 50 Hz, 11000 V/440 V, 100 kVA transformer is 99%, while supplying the 50% of the rated load current with unity power factor. The rated core loss of the transformer is 267.313 W. Determine the wattmeter reading (W_sc, in W) during the short circuit test on the transformer where the rated current is allowed to flow. **[3]**

2. During open circuit (OC) test on low voltage side, a single phase 2500 V/250 V, 50 Hz transformer gives 100 W of rated core loss. If the OC test is performed with 125 V supply in the low voltage side, determine the core loss (W_core, in W) of the transformer. **[3]**

3. The rated copper loss of a 120 MVA, 50 Hz single phase transformer is 9 times of the rated core loss. Determine the active power (P_act, in MW) that can be supplied to a load connected to the transformer when the transformer is operating with maximum efficiency. The load power factor is 0.8 (lag). **[3]**

4. A 400 V/100 V two winding transformer is connected as an auto-transformer that delivers a load at 400 V from 500 V source. If the rating of the auto-transformer is 50 kVA, determine the rating of the two-winding transformer (S_TF, in kVA). **[3]**

5. The approximate voltage regulation of a two winding transformer is 6%. If the equivalent inductance (X_{eq}) of the transformer is 0.06 pu, determine the ohmic loss of the transformer (P_cu, in pu) in per unit. The transformer is loaded with the rated load and the power factor is 0.6 (lag). **[3]**

6. A load of 6+j8 Ω is connected to the LV winding of a 2 kVA, 250 V/125 V, 50 Hz single phase ideal transformer at its rated voltage. The shunt branch is neglected. If the ratings of the transformer are selected as base, determine the magnitude of the load current (IL, in pu) in per unit refereed to the HV side of the transformer. **[3]**

7. A DC motor is acting as the prime mover of a DC generator. The DC motor is coupled with DC generator through the shaft. The nameplate rating of the DC generator is 100 kW, and the generator efficiency at rated load is 80%. Estimate the nameplate rating of the motor (P_NPR, in kW). **[3]**

8. A 4-pole DC shunt motor is wave wound with 500 conductors. If the flux per pole is 0.0188 Wb/pole, and the motor rotates with a speed of 25 rps (revolutions per second), then determine the back emf induced (Eb, in V) in the armature. **[3]**

9. A 300 V separately excited DC generator delivers 100 A to a load, while rotating at 1600 rpm. Now, if the load current is increased to 150 A by keeping the terminal voltage and flux constant, determine the speed (N_g, in rps) of the generator. Armature resistance $R_a = 0.2\ \Omega$, and neglect brush drop. **[3]**

10. An inductive coil has the resistance of 30 Ω, however, its inductance is not known. The coil is connected in parallel with a 100 Ω resistance and the combination when connected across a 100 V, 60 Hz source, draws 400 W. Determine the inductance (L, in mH) of the inductive coil. **[3]**

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SEMESTER-I, 2022-2023

ELECTRICAL MACHINES (MIDSEM) EEE_ECE_INSTR F211 (Part-B)

Date-03/11/2022 Total Marks: 15×3M=45 Duration: 60 min

[Take necessary assumptions with proper justifications whenever required]

[Write your answers up to four decimal places, If the final answer is a complex number then express it in polar form]

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1. Consider a 200 kVA, 2500 V/250 V, 50 Hz, two winding transformer which is represented by exact electrical model. The load is connected to the LV side whereas, the source is connected to the HV side of the transformer. The HV side series branch parameters are $R_1(HV) = 0.25\ \Omega, X_1(HV) = 0.50\ \Omega$, and the shunt branch parameters are $R_c\ (HV) = 10\ k\Omega, X_m(HV) = 1.50\ k\Omega$ respectively. The LV side parameters are $R_2\ (LV) = 2.5\ m\Omega, X_2(LV) = 5.0\ m\Omega$. The load which is connected at the LV side draws the rated current with the rated terminal voltage with 0.8 power factor leading.
   i. Determine the HV side induced emf (E_1(HV), in V). **[3]**
   ii. Determine the no load current in the HV side (I_0, in A). **[3]**
   iii. Determine the core loss of the transformer (W_c, in W). **[2]**
   iv. Determine the current (I_S, in A) taken from the source in the HV side. **[3]**
   v. Determine the supply voltage (V_s, in V). **[2]**
   vi. Determine the source side power factor (pf_s). **[2]**

2. Sumpner's test is conducted on two identical transformers each rated for 10 kVA, 200 V/500 V, 50 Hz. The two LV windings are connected in parallel and are fed from the rated supply. The two HV windings are connected in phase opposition and are connected to auxiliary supply so that rated current flows through the HV windings. The readings of the meters connected on LV side and the HV sides are as follows:

   LV Side: 200 V, 4.2 A, 240 W

   HV Side: 110 V, 20 A, 480 W

   i. Determine the efficiency (eta_tf, in %) of the individual transformer at 25% of the rated load with 0.85 power factor lagging. **[3]**
   ii. Calculate the all-day efficiency (eta_allday, in %) of the individual transformer, if the individual transformer operates with the following load pattern of 24 hours. **[4]**

Duration (in Hours)	Load (%)	Power Factor
16	40	0.9 (lead)
8	125	0.8 (lag)

   iii. Find the approximate voltage regulation (VR_approx, in %) of the individual transformer at 50% of the rated load with 0.9 power factor leading. **[4]**
   iv. Draw the approximate equivalent circuit of the individual transformer referred to LV side, showing all the parameters (Rc, Xm, Req and Xeq) in per unit. Considered the transformer rated values as the base. **[4]**

3. A 4-pole lap wound DC Shunt generator is supplying 5 kW Geyser load and 2.5 kW lighting load at the terminal voltage of 250 V. The Geyser load and lighting load are connected in parallel. The generator has an armature resistance of 0.2 Ω and a field resistance of 250 Ω. The armature has 20 slots and each slot has 6 conductors. The armature of the generator is rotating at 1000 rpm. Assuming the total brush voltage drop as 2 V, determine the following

   i. Armature-current (Ia, in Amp) in each parallel path. **[2]**
   ii. Total copper loss (P_cu, in kW) of the generator. **[2]**
   iii. Flux per pole (phi_pole, in mWb). **[2]**
   iv. Efficiency (eta_G, in %) of the generator, if the net rotational loss is 420 W. **[2]**

   If the same DC shunt generator is now operated as a DC shunt motor with a supply voltage of 250 V and running at a speed of 1000 rpm by keeping the armature current constant, determine

   v. The EMF (Eb, in V) induced in the armature, in DC shunt motor. **[2]**
   vi. The gross torque (T_gross, in N-m) developed in the motor. **[3]**
   vii. Efficiency (eta_M, in %) of the DC shunt motor if the rotational loss is 420 W. **[2]**

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