Reg. No. \_\_\_\_\_\_\_\_\_\_\_\_\_



**End Semester Examination – Nov / Dec – 2019**

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| **Code :** | **18EE3017** | **Duration :** | **3hrs** |
| **Sub. Name :** | **POWER CONVERSION AND CONTROL OF WIND ENERGY SYSTEMS** | **Max. Marks :** | **100** |

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| **Q. No.** | **Sub Div.** | **Questions** | **Course Outcome** | **Marks** |
| **ANSWER ANY FIVE QUESTIONS (5 X 16 = 80 MARKS)** | | | | |
| 1. |  | A 2.0 MW, 690V, 11.25Hz salient pole PMSG is used in a standalone wind energy system. The parameters of the generator are given below.  Number of pole pairs=30  Rated rotor speed=22.5 rpm  Stator winding resistance Rs=0.73051mΩ  d-axis synchronous inductance Ld=1.21mH  q-axis synchronous inductance Lq=2.31mH  rated rotor flux linkage λr=4.696Wb (rms)  The generator is connected to an RL load. The load parameters are given by RL=0.19125Ω and LL=1.3104mH. At a wind speed of 12.0m/s, the generator operates at 1.0pu rotor speed. Neglecting the rotational and stator core losses, determine the following.  a) The rotor mechanical and electrical speeds and load impedance value.  b) The dq axis and rms stator currents.  c) The dq axis and rms stator voltages.  d) The mechanical power and torque.  e) The stator winding loss and power factor  f) The Stator active and reactive powers and efficiency | CO1 | 16 |
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| 2. |  | With relevant equivalent circuit diagrams, elucidate space vector model and dq reference frame model of induction generator in detail. Also explain the simulation model of induction generator. | CO1 | 16 |
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| 3. | a. | With relevant equivalent circuit diagrams, elucidate different configurations with full capacity back to-back power converters used for variable speed synchronous generator WECS. | CO3 | 8 |
| b. | With relevant equivalent circuit diagrams, elucidate different configurations of fixed speed wind energy systems with Squirrel Cage Induction Generator. | CO3 | 8 |
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| 4. |  | Consider 2.3MW, 690V, 50Hz SCIG wind energy system operating with direct Field Oriented Control. At a wind speed of 12 m/s, the generator operates at 1.0 p.u rotor speed. With the rated stator voltage of 690V and rated slip of -0.008, the parameters of the generator are given below.  Number of pole pairs=2.  Rated rotor speed=1512 rpm.  Rated mechanical torque=14.74 kN-m.  Stator winding resistance Rs=1.102mΩ.  Rotorr winding resistance Rr=1.497mΩ.  Stator leakage inductance Lls=0.06492mH.  Rotor leakage inductance Llr=0.06492mH.  Magnetizing inductance Lm=2.13461mH.  The rotor flux λr is kept at its rated value of 1.7106Wb (peak) by the direct field oriented controller.  Calculate the following:  a) The generator mechanical torque and power.  b) The stator and rotor currents.  c) The magnetizing, stator and rotor flux linkages.  d) The dq axis stator currents.  e) The dq axis stator voltages | CO4 | 16 |
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| 5. |  | With relevant equivalent circuit diagrams and waveforms, explain the operation of single channel boost converter. Also find the expression for the following:  a) Output voltage and current.  b) Ripple current in the inductor.  c) Output ripple voltage.  d) Maximum inductor boundary current at DCM.  e) Maximum output boundary current at DCM. | CO2 | 16 |
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| 6. |  | With relavent system block digrams explain the DFIG wind energy system with stator voltage oriented control. Also find the expression for the following.  a) dq axis stator flux linkages.  b) dq axis stator currents.  c) The electromagnetic torque.  d) Stator active and reactive power.  e) dq axis rotor currents. | CO5 | 16 |
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| 7. |  | Elucidate following control methods used for synchronous generators  a) Zero d-Axis Current (ZDC) Control.  b) Maximum Torque Per Ampere (MTPA) control.  c) Unity Power Fctor (UPF) Control. | CO6 | 16 |
| **COMPULSORY QUESTION (1 X 20= 20 MARKS)** | | | | |
| 8. | a. | With relevant equivalent circuit diagrams and waveforms, explain the operation of two level voltage source inverter with space vector modulation in detail. Find the expression for the dwell times. Also explain the procedure to obtain the gating signals for the inverter switches. | CO2 | 12 |
| b. | A single phase AC voltage controller has an input voltage of 220V (rms) 50Hz and a load resistance of 10 Ω. The converter operates at a firing angle of 450. Assuming that the converter is ideal, calculate the following.  i) The rms voltage and current.  ii) The load apparent, active and reactive powers.  iii) The rms and thyristor currents.  The input apparent, active and reactive powers and input power factor. | CO2 | 8 |