

Birla Institute of Technology and Science, Pilani
First Semester 2022-2023
EEE/INSTR/ECE F211: Electrical Machines
Comprehensive Examination (closed Book): Part B
Date: December 23th, 2022 **Time: 2 Hrs** **MM: 70**

- Q1 (a) Why are the single phase induction motors are not self-starting? Explain in brief.
- (b) A three phase delta-delta bank consists of three 25 kVA, 3300/300 V transformers and supplies a load of 40 KVA. After removing one transformer, determine the following for open delta connection
- (i) Line currents at primary and secondary sides
 - (ii) kVA load carried out by each transformer
 - (iii) The maximum kVA load which this open delta combination can supply. [5+10]
- Q2(a) Show that in induction motor, autotransformer starting reduces the starting torque and starting line current by a factor x^2 (x is tapping in auto transformer) as compared to direct on line starting.
- (b) A 208 V, 4 pole, 7.46 kW, 60 Hz, Y-connected three phase induction motor develops its full load torque at 3.8% slip. The values of per phase circuit model parameters of motor are
- $R_1 = 0.33 \text{ ohm}; \quad X_1 = 0.42 \text{ ohm}; \quad X_m = 16 \text{ ohm}; \quad X_2' = 0.42 \text{ ohm}; \quad R_2' \Omega$
- Mechanical, core, and stray losses are neglected. For this motor,
- (i) Find the value of rotor resistance R_2'
 - (ii) Find value of maximum torque & corresponding slip and the rotor speed at maximum torque
 - (iii) Find the starting torque
 - (iv) Now an external resistance (R_{ext}) is added in the rotor circuit to change the starting torque, find the value of R_{ext} so that the starting torque is 50 Nm. [5+20]
- Q3(a) Prove that at no load, synchronous motor behaves like a variable reactor.
- (b) A 1100V, 3-phase, 50 Hz, star-connected synchronous motor takes 96 kW at 0.8 pf lagging. Its synchronous reactance X_s is 5 Ω . For this motor,
- (i) find the excitation emf
 - (ii) if the excitation emf is increased by 40% keeping the same load, find new values of armature current, power factor and load angle.
 - (iii) for the excitation emf as in part (b), determine the maximum power that motor can deliver and corresponding value of armature current. Also draw phasor diagram for this case. [5+15]
- Q4 A 500 V, 4-pole DC shunt motor has 944 wave-connected armature conductors. At a certain load the flux per pole is 34.6 mWb and the total electromechanical power developed is 4 kW. The armature resistance of the motor is 0.8 Ω and field resistance of the motor is 250 Ω . Calculate:
- (i) the armature current drawn by the motor
 - (ii) speed at which motor will run
 - (iii) input to the motor
 - (iv) efficiency of the motor [10]

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First Semester 2022-2023
EEE/INSTR/ECE F211: Electrical Machines
Comprehensive Exam (Closed Book): Part A

Date: 23.12.2022

Max Time: 1Hr.

Max Marks: 35

Note: Write your answers clearly in the blanks as per the unit given.

Q1-Q6 each correct blank carries 1 Mark and Q7-Q20 each correct blank carries 1.5 Marks.

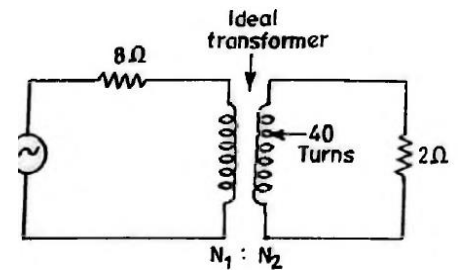
Name: _____

ID No: _____

Sec. No. _____

- Q1 In a synchronous machine, if $E_f \cos\delta > V_t$, the machine is _____ excited (Over/under).
- Q2 In a single phase induction motor, resistance split phase motor has _____ torque-speed performance as compared to capacitor split phase motor. (poor/better)
- Q3 In a DC machine, commutation happens along with _____ (magnetic neutral axis/geometric neutral axis).
- Q4 The armature reaction in saturated DC machine leads to _____ of main flux. (weakening/strengthening)
- Q5. The vector group of a transformer is defined as $Yd2$. The low voltage side is connected in _____ and leads high voltage side by _____°.
- Q6 A 3-phase synchronous motor, connected to an infinite bus, operates at leading power factor. For constant load torque, if excitation is increased, power angle will _____ and phase angle between terminal voltage and armature current will _____. (increase/decrease)

- Q7 The secondary winding of the ideal transformer shown in Fig. has 40 turns, the number of turns in the primary winding for maximum power transfer to the 2Ω resistor will be _____.



- Q8 A transformer has leakage impedance of $Z = R + jX$. Its maximum voltage regulation occurs at a power factor of _____ lagging.
- Q9 A 20 kVA, 2300 V/230 V, two winding transformer is to be used as an autotransformer to give 2530 V/2300 V. Power rating of this autotransformer will be _____ kVA.
- Q10 A 3-phase delta-star transformer has per phase secondary to primary turn ratio of 5. For a primary line current of 10 A, the secondary line current would be _____ A.
- Q11 A 48-slot, 3 phase, 4 pole synchronous generator has coil span of 10 slots. The pitch factor is _____ and distribution factor is _____.

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- Q12 A 4 pole dc generator runs at 1500 rpm. The frequency of current in the armature winding is _____Hz.
- Q13 A 220-V, 1400 rpm dc shunt machine has an armature resistance of 1Ω . The total voltage drop on account of brush drop is 3V and the armature current is 10 A. The emf induced while running as motor is _____V and speed of machine while running as generator is_____ rpm.
- Q14 A squirrel cage induction motor drives a constant-torque load, if supply voltage reduces by a factor of 0.707 then the slip will increase by a factor of _____and current will get increased by a factor of _____.
- Q15 The speed of a 3-phase induction motor is controlled by controlling its supply frequency. If the speed of the machine is reduced by reducing the frequency by 50% of the rated frequency; to keep the flux in the machine constant, the motor voltage compared to rated voltage must be reduced by _____%.
- Q16 When the supply voltage to a 3-phase squirrel cage induction motor is reduced by 20%, the maximum torque will decrease by _____%.
- Q17 A 3-phase star connected induction motor is fed from 400 V, 50 Hz source. At a rotor speed of 1440 rpm, the rotor induced emf/phase would be_____ V.
- Q18 A 3 phase induction motor connected in star draws a line current of 20 A from the supply mains. If the motor is now connected in delta, the line current drawn from supply is _____A.
- Q19 A 8 pole, 50 Hz 1-phase induction motor runs at 725 rpm. The forward slip is _____and backward slip is _____.
- Q20 A 3-phase, 400 V, 50 Hz, synchronous motor is operating with a load angle of 20° , if frequency is increased by 10%, keeping other parameters constant, the new load angle will be_____ $^\circ$.