TANTA UNIVERSITY

Electrical Power and Machines Department

Faculty of Engineering

Final EXAM 2015/2016- Second Term

Course	Special Electrical Machines(EPM4230)	Time Allowed	3 hours
Students	4thYear (Electrical Power and Machines)	Total Mark	75
Date	Sat. 28thMay, 2016	Number of pages	3

قبل أن تبدأ إجابتك الرجاء قراءة التعليمات العامة الآتية والالتزام بها بكل دقة:	
١. اكتب رقم السؤال بوضوح.	٢. استخدم الرسومات التوضيحية ذات البيانات الواضحة والكاملة كلما أمكن.
٣. أجب بوضوح سواء باللغة الإنجليزية أو العربية.	٤. لا يشترط الإجابة بترتيب الأسئلة في ورقة الامتحان.
٥. افترض قيمًا معقولة لأية بيانات ناقصة.	٦. فيما عدا الرسومات تجنب قدر لا تستخدم القلم الرصاص إلا في أضيق الحدود
٧. ابدأ إجابة كل السؤال في بداية صفحة جديدة (إلا إذا تعذر ذلك)	٨. تجنب تمامًا في إجاباتك استخدام: • اللونين الأحمر والأخضر • سائل التصحيح corrector

Attempt ALL the following questions and problems:

The First Question (15 points)

Write down in your answer sheet the statement number ONLY followed by either ✓ mark for correct statements or X mark for incorrect ones. Explanation is not needed!

1.	Starting (auxiliary) winding of single phase induction motors is to have high value of R/L.
2.	Staring torque of a single phase induction motor increases with increasing phase angle between main winding current and applied voltage.
3.	Motion direction of shaded-pole motors can be reversed by reversing supply polarity
4.	AC-excited universal motors have the disadvantage of producing pulsating torque.
5.	Compensating winding is used in to improve power factor of universal motors.
6.	Output frequency of grid-connected induction generator depends on prime mover speed.
7.	Self-excitation of induction generators is more possible for lower load impedance.
8.	Synchronous reluctance motors have the advantage of controllable power factor operation
9.	For surface-mounted permanent magnet motors, the direct axis inductance is greater than quadrature axis inductance
10.	Operation of permanent magnet motors of sinusoidal type requires high resolution position sensor
11.	The application of voltage hard chopping for switched reluctance motor reduces the system noise.
12.	At deep saturation conditions, the phase inductance at the unaligned position may be equal or greater to aligned position.

Please turn over

13.	Rotation direction of permanent magnet stepper motor is reversed by changing excitation sequence.
14.	The operation of linear induction motor depends on the eddy current following in the magnetic core.
15.	SRM as well as stepper motor cannot operate directly from electrical mains. However, they operate efficiently in open loop mode,

The Second Question (18 points)

1.	For a capacitor run induction motor: a) Draw *ONLY* with complete details, the equivalent circuit. b) Obtain the motor voltage equations that can be used to calculate main and auxiliary currents in terms winding parameters and capacitance reactance.
2.	Explain with derivation how to determine the required capacitance of a split motor induction motor to achieve maximum starting torque.
3.	A 1/3 hp, 110-V, 60-Hz, 6-pole, split-phase single-phase induction motor has the following circuit parameters (referred to the stator main winding): R_1=1.52 Ω X_1 =2.1 Ω R'_2=3.13 Ω X'_2 =1.56 Ω and X_{mag} = 58.2 Ω, The core losses of the motor are 35 W. Friction, windage and stray loss is 16 W. The motor is running at the rated voltage and frequency while its starting winding is open and the motor slip is 5 percent. Calculate the following quantities: a) Stator current b) Motor power factor. c) Developed torque d) Motor efficiency

The Third Question (11 points)

1.	Compare in details between dc and ac operation of single-phase universal motors
2.	The resistance and total inductance of a single-phase series motor are 35 Ω and 0.55 H respectively. It draws a current of 0.85 A and runs at 1800 r/min when connected to a 250-V DC supply. Calculate speed and power factor when it is connected to a 250-V, 50 Hz supply and loaded such that it draws the same current.
3.	*For three phase stand-alone induction generators:* a) Explain the process of voltage build-up. b) Clarify how to guarantee self-excitation. c) Sketch with sufficient information different generator characteristics

The Fourth Question (11 points)

1.	*For three-phase synchronous reluctance motors*: a) Derive and sketch the torque-angle characteristics considering armature resistance. b) Give notes about employed rotor configurations

Please turn over

2.	*For permanent magnet motors:* a) Clarify the differences between trapezoidal and sine-wave- wound types. b) Give notes about rotor configurations. c) Explain how operation at higher speeds is affected by rotor type.

The Fifth question (20 points)	
1.	Define the following terms: • Reaction plate. • Magnetic levitation
2.	Explain the differences between the following pairs: • Iron core and Ironless core of linear motors • Slot and slotless single sided linear motors
3.	A 3-phase 12/8 VRM has stator pole arc of 20°and rotor pole arc of 22°, air gap length g=3mm, active length=20cm. The stator and rotor iron can be considered to be of infinite permeability. Defining the zero of rotor angle at the position of phase-1 full alignment. 1. Draw the machine lamination showing the flux path when phase 1 is excited at the aligned position. 2. Plot with labels the inductance variation of all phases against rotor position. Mention the equations used. 3. If each pole has 100 turns and a constant current of 7.5 ampere flows in phase-1 at the position of maximum inductance. Find the airgap flux density. Make any required assumptions
4.	A single sided Maglev permanent magnet linear motor vehicle with combined propulsion and levitation of PM-LSM. When the vehicle is running on-land with airgap of 9mm, the trust force coefficient K_{F0} = 10.93N/A. The levitation force coefficients are: 1. force between iron stator and current-carrying windings $K_{zS}(\delta_e)$ = 3.1N/A^2 2. force between the stator current and PM $K_{zMs}(\delta_e)$ = 45.3N/A 3. force between PM and stator laminated-iron $K_{zM}(\delta_e)$ = 12.4N The total vehicle weight is 11Kg. The armature windings are supplied with balanced three phase of I_1=4A Find the mechanical load angle as a ratio of pole pitch. Determine the attractive and repulsive components of levitation forces. If the hydrodynamic resistance force F_{xR}(N) is expressed as a function of running speed v(m/s), it is found to be: $$F_{xR} = 60.76\ v^2$$ Find the running speed in the above conditions. Determine supply frequency at this condition.

Good Luck and best wishes

Prof. Essam Eddin M. Rashad, Dr. Mohamed K. El-Nemr and Exam Committee

Electrical Power and Machines Engineering Department

Tanta University | Total Marks: **75 Marks** | Faculty of Engineering

Course Title: Application of Power System Protection	Course Code: EPM4229	Year: 4th
Date: June 2016 (Second term)	Allowed time: 3 hrs	

Answer the following questions

Problem number (1) **(25 Marks)**

a) Explain using graph only; the typical protection for direct connected and unit connected generator.

b) The unit generator shown in Fig. 1 has a capacitance-to-ground of value 0.2885 microfarads per phase and the ground resistor R has a 64.14 kW rating at 138 V.

i. Will 87G relay trip for a SLG fault occurred at F1 between the generator and transformer?
ii. Specify the response for relays 59G and 50/51G against the fault mentioned in (i).
iii. Repeat the above requirements in (i) and (ii) if the type of fault is line-to-line fault at the same location.

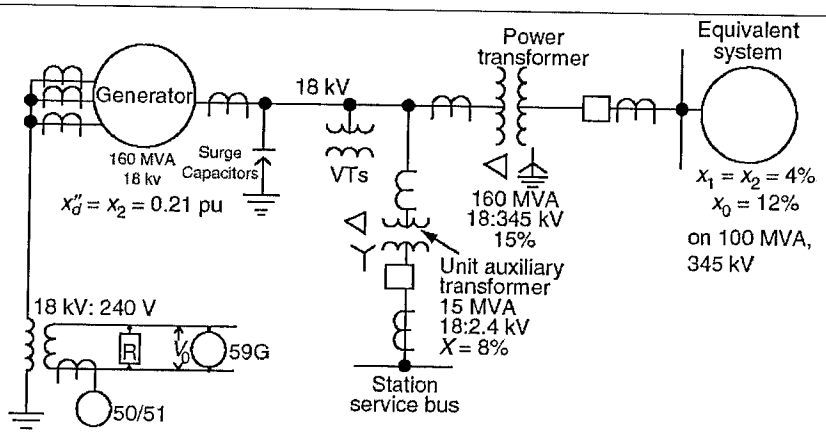


Fig. 1 System for problem 1.b

c) Figure 2 shows a percentage differential relay applied for the protection of a generator winding. The relay has a 0.1 A minimum pickup and a 10% slope. A high-resistance ground fault has occurred as shown near the grounded-neutral end of the generator winding while it is carrying load with the currents flowing at each end of the generator as shown. Assume that the CT ratios are as shown in the figure and they have no error. Will the relay operate to trip the generator under this condition? Would the relay operate if the generator were carrying no load with its breaker open? Draw the relay operating characteristic and the points that represent the operating and restraining currents in the relay for the two conditions.

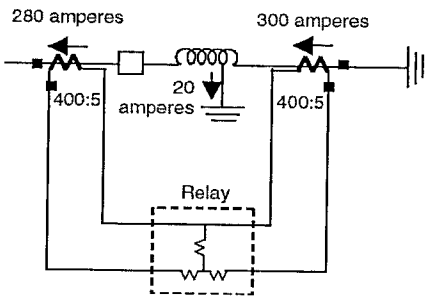


Fig. 2

Problem number (2) **(25 Marks)**

a) Explain using graph only; the typical protection for two-winding power transformer.

b) For the transformer bank of Fig. 3, assume that phases A, B, C on the 13.8 kV side have 3000/5 CTs with taps at 1500, 2000, 2200, and 2500 A, and that the 69 kV circuits a, b, c have 600/5 multi-ratio CTs with taps at 400, 450, 500, and 550.

i. If the differential relay has taps of 4, 5, 6, and 8, select suitable taps for relay and CT to make the percent mismatch less than 10%.
ii. If phase-a-to-ground fault is within the differential zone, how much current can flow in the differential relay(s)? How many of the three relays operate for this ground fault?

Course Title: Application of Power System Protection	Course Code: EPM4229	Year: 4th
Date: June 2016 (Second term)	Allowed time: 3 hrs	

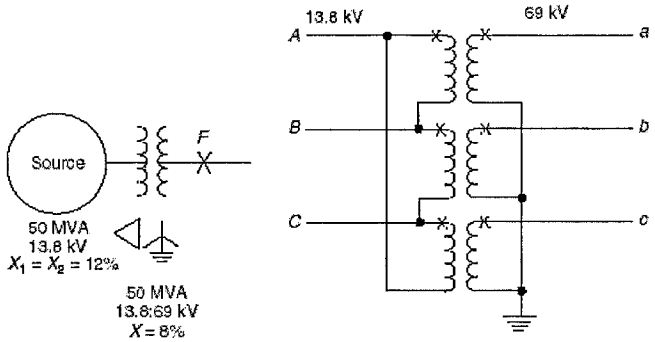


Fig. 3 System for Problem 2.b

Problem number (3) **(25 Marks)**

a) Explain using graph only; the typical protection for three-phase induction motor.

b) Design the bus protection for the system shown in Fig. 4. Show the location of the primary CTs and draw the three-phase secondary wiring of the two bus differentials. Discuss the relay applications involved.

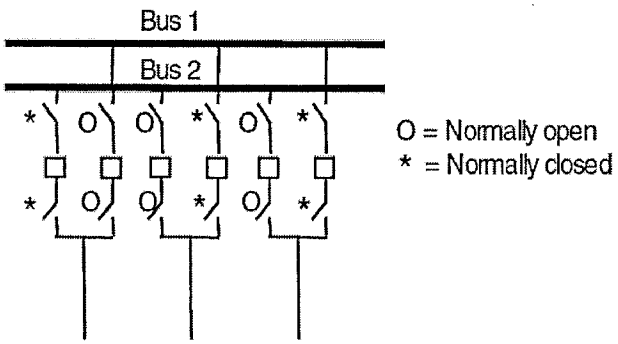


Fig. 4

c) A 2850 hp, 4 kV induction motor is connected to the supply system through a 2.5 MVA transformer, 13.8 : 4 kV with a reactance of 5.8%. The motor full load current is 362 A and its locked rotor current 1970 A. The supply system short circuit MVA at the 13.8 kV terminals of the transformer is 431 maximum, 113 minimum, on 100 MVA base. Determine if a phase instantaneous over current relay can be applied if it is set at half the minimum fault current and twice the locked rotor current.

Good Luck

Course Examination Committee: Dr. Mohamed Abo Elazm

Tanta University Faculty of Engineering Electrical Power and Machines Engineering Fourth Year/ Second Term	Elective Course (4) Programmable Logic Controllers Final Exam 2015/2016 Time: 3:00 hours - Max points: 85

Question I: [20 points points] answer the following questions:

(1) What are the main components of PLC system? Describe the functionality of each component.

(2) Explain briefly the scanning process of PLC.

(3) Discuss the importance of signal conditioning, support your answer with two example circuits.

(4) Show the difference between:

- On-delay and off-delay times
- Internal and external relays

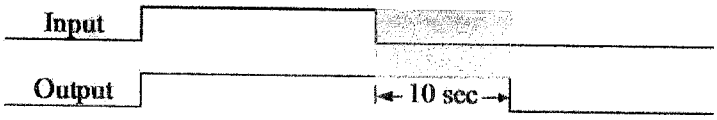
Question II: [15 points points] state true or false and correct the false statements.

(1) The parallel data communication interface enables data to be transmitted over short distances at high speeds. It has a common standard known as IEEE-488.

(2) The retentive timer must be intentionally reset with a separate signal.

(3) The OR function is implemented using contacts requires contacts to be connected in series.

(4) The timing diagram shown is expressing an ON-delay timer.



(5) A PLC up-counter normally counts the true to false transitions.

(6) The optical-isolator is used to electrically isolate the inputs from the outputs.

(7) A relay output channel from a PLC is used for only DC switching.

(8) A relay output channel from a PLC can withstand transient overloads.

(9) The reason for including optical couplers on input/output units is to provide a fuse mechanism that breaks the circuit, if high voltages or currents occur.

(10) A TRIAC output channel from a PLC is used for only AC output loads.

(11) For communications over distances of the order of 100 to 300m with a high transmission rate the RS232 interface can be used.

(12) Shift registers require two inputs: one to load data into the first location of the register and one as the command to shift data along by one location.

Question III. [10 points points] select the correct answer(s), comment your choice briefly.

(1) An ADC is used to sample the output voltage from a pressure sensor. If the output from the sensor is 0V when the pressure is 0kPa and 10V when it is 10kPa, the minimum number of ADC bits needed to resolve the sensor output if the sensor error is not to exceed 0.01 kPa is:

a. 4 b. 8 c. 10 d. 12

(2) For the hardwired relay circuit shown below, when PB1 is momentarily pressed:

a. R is de-energized.
b. G is energized.
c. M is energized.
d. All of the above.

(3) For the ladder diagram shown when there is an input to I0.0, the output Q2.0:

a. Comes on and remains on for one cycle.
b. Comes on and remains on.
c. Goes off and remains off for one cycle.
d. Goes off and remains off.

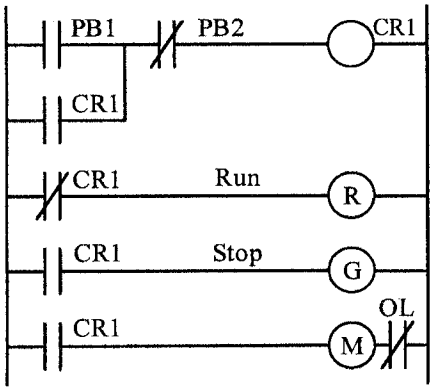


Diagram of Q3.2

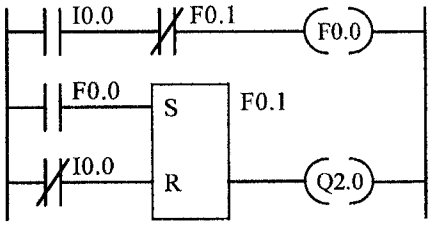
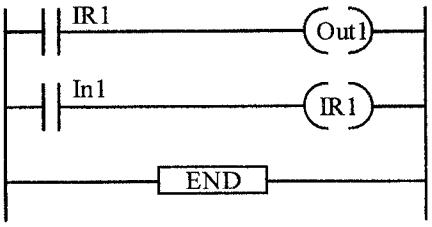


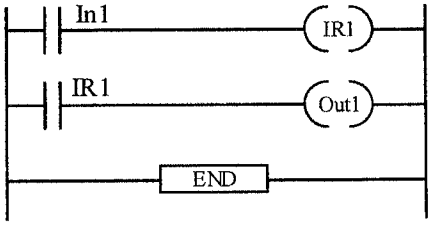
Diagram of Q3.3

(4) Which one of the programs will give an output from Out1 in the same program scan as there is an input to In1?

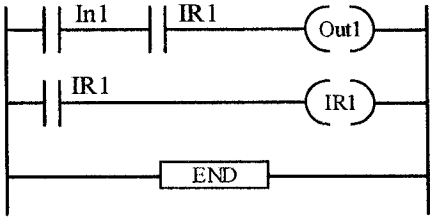
a.



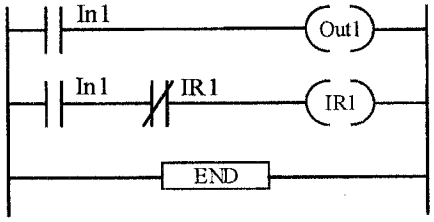
b.



c.



d.



(5) An inverting operational amplifier circuit has an input resistance of 10 kΩ and feedback resistance of 100 kΩ. The closed-loop gain of the amplifier is:

a. -100
b. -10
c. 10
d. 100

(6) For the shown diagram, output Out 1 occurs when:

a. Only input In1 must occur
b. Both inputs In1 and In2 must occur
c. Input In1 must not occur and In2 must occur
d. Both inputs In1 and In2 must not occur

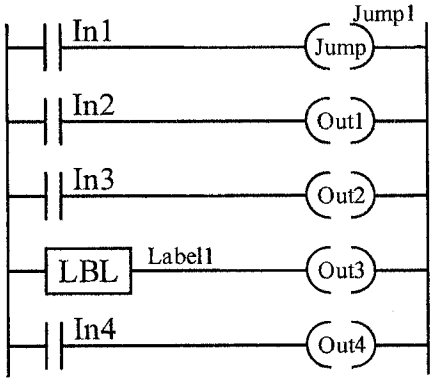
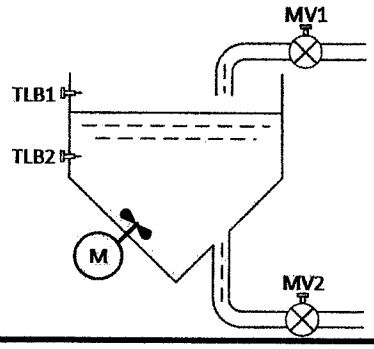


Diagram of Q3.6

Question IV. [10 points points]

Write the PLC ladder code that executes the following sequence (using SIEMENSE S7-300 syntax) along with the necessary hardware configuration listed in the standard SIEMENSE order for the utilized rail.

1- As the start push button (S1) is pressed, MV1 opens and the water begins to fill the tank. At the same time, the stirring motor (M) starts to operate.
2- When the water level passes TLB2 and reaches TLB1, the MV1 closes and the stirring motor stops.
3- As the start push button (S2) is pressed, MV2 opens and starts draining the water. When the water level drops below TLB2, MV2 closes.



Question V. [15 points points]

Write the PLC ladder code that executes the following sequence for a machine that being designed to wrap boxes of chocolate. The boxes arrive at the machine on a conveyor belt. The list below show the process steps in sequence.

1- The box is manually inserted on a conveyor by the operator.
2- The push button START is pressed by the operator and the conveyor (C) starts moving.
3- Process stops operating when the STOP button is momentarily pressed.
4- The box arrives and is detected by an optical sensor (P). After this the conveyor (C) is stopped and the box is clamped in place (H).
5- A wrapping mechanism (W) is turned on for 2 seconds.
6- A sticker cylinder (S) is turned on for 1 second to put consumer labeling on the box.
7- The clamp (H) is turned off and the conveyor (C) is turned on.
8- Every 8 boxes, the conveyor stops and alarm lamb (A) is turned-on to allow the operator to change the package. A new push to START button will reset the counter.

Question VI: [15 points points]

Develop a PLC ladder that operate a traffic sign for cars and man in a street crossing (use SIEMENS S7-300 syntax). The operating sequence should be repeated as follows:

Step	Time (Sec)	Cars Sign			Man Sign	
		Red	Yellow	Green	Red	Green
1	30	Off	Off	On	On	Off
2	5	Off	On	Off	On	Off
3	2	On	Off	Off	On	Off
4	20	On	Off	Off	Off	On
5	3	On	Off	Off	Off	Off

With all best wishes

٤ قوى كهربية

Tanta University

Department: Elec. Power and Machines Engineering
Total Marks: 85 Marks

Faculty of Engineering

Course Title: Control in Electrical Power Systems (2)	Course Code: EPM4228	Year: 4th
Date: 8 Jun 2016	Allowed time: 3 hour	No. of Pages: 2

Answer the following questions:

Question (1) (25 Marks)

a) **Define** the following terms: (10 Marks)

1. Load damping constant
2. Isochronous governor system
3. Speed droop coefficient
4. Voltage stabilizer
5. ACE

b) What will be happen in power system performance if: (15 Marks)

1. the voltage level is decreased below the minimum level.
2. the frequency of power system is unfixed.
3. series capacitor is connected at the receiving end of transmission system.
4. shunt capacitor is connected at the receiving end of transmission system.
5. many loads of leading power factor are connected at the receiving end of short transmission line.

Question (2) (30 Marks)

a) Draw the schematic diagram representing one generating unit with droop coefficient (R_1), then sketch the following: (10 Marks)

1. Speed response for step increase in load at droop characteristic R_1.
2. Speed response for step increase in load at droop characteristic $R_2 = 2R_1$.
3. If AGC is applied on this unit and connected to interconnected areas with AGC, draw the schematic diagram of the system with primary and supplementary control showing the objectives of each control system.

b) Explain using schematic diagram and sketches how the automatic voltage regulator can control in the terminal voltage of a generating unit. (10 Marks)

c) If PID controller is added to AVR system, Draw the schematic diagram showing the role of PID in the output voltage. (10 Marks)

Question (3) (30 Marks)

a) Explain the function and draw the schematic diagram of UPFC used in power system. (5 Marks)

b) Define the SCADA system and mention its main components? (8 Marks)

c) Draw the equivalent circuit of three different types of SVC used in power system. (5 Marks)

d) Determine which of the following produce and/or absorb reactive power: transformer, TL and underground cables, mention reasons. (6 Marks)

e) Define the role of the following components used in substation: (6 Marks)
1. Current transducer
2. Auxiliary relay
3. Remote terminal units

Best wishes
Dr. Doaa Mokhtar

Tanta University
Faculty of Engineering
Electrical Power and Machines Engineering Dept.

Final Exam – Second Semester 2015-2016

Course: EPM4227 (Electric Drives)	**Time allowed**: 3 hour
Year: 4th Electrical Power and Machines Eng.	**Date**: 13/6/2016
No. of Pages: 4	**Total Score:** 90

Remarks: *Attempt to solve all of the following questions*

Question - 1		**15 points**
1)	Explain how to measure the moment of inertia of a motor drive system.	
2)	What will be happened if a torsion elasticity is exist in shaft coupling the load to the motor?	
3)	A motor equipped with a flywheel is required to drive a load has a toque of 600 Nm for 10 sec followed by a no-load period long enough for the flywheel to regain its full-load speed. It is desired to limit the motor torque to 450Nm. What should be the moment of inertia of the flywheel? The no load speed of the motor is 600 rpm and it has a slip of 6% at torque 400 Nm. Assuming the motor speed-torque characteristic to be straight line in the range of operation. Motor has an inertia of 10 Kg-m^2.	

Question - 2		**15 points**
1)	List the measures that could be taken to conserve energy in electrical drives.	
2)	Explain how the variable speed drive allows saving of energy in pump drives.	
3)	A 100- ton motor coach is driven by 4 motors, each developing a torque of 4000 N-m during acceleration, climbs up- gradient with G= 40. Gear ratio a= 0.25, gear transmission efficiency is 95%, wheel radius is 0.6m, train resistance is 25 N/ton, effective mass on account of rotational inertia is 10% higher. Calculate the time taken to attain a speed of 100 *Km/hr*.	

Question - 3		**15 points**
1)	What are the technical considerations, which governed the choice of a dc motor for a variable speed drive?	
2)	An electric bus has a mass of 12 ton is driven by 2 motors, one for each wheel axle and each motor rotates by 1500 rpm. If up gradient is 20, gear ratio a =0.2. Each wheel has a radius of 0.5 m and each has a mass of 150 kg. Calculate the coupling torque and power rating per motor required to accelerate the bus at 5 km/hr/s. Assuming bus resistance to be 30 N/ton of weight.	

Question - 4	**15 points**
1)	The speed of a separately excited dc motor is controlled by a single-phase full-converter. The field-circuit is also controlled by a single-phase full-converter and the field current is set to the maximum possible value. The ac supply voltage to the armature and field converters is single-phase, 220 V, 50 Hz. The armature resistance is R_a=0.25 Ω, the field circuit resistance is R_f = 175 Ω, and the motor voltage constant is K_v=1.4 *V/A-rad/s*. The armature current corresponding to the load demand is I_a = 45 A, the viscous friction and no-load losses are negligible. The inductances of the armature and field circuits are sufficient to make the armature and field currents continuous and ripple-free. If the delay angle of the armature converter is α_a=60 and the armature current is I_a=45 A. Determine the following (a) Torque developed by the motor, T_d; (b) Speed, ω ;and (c) Input power factor of the drive, *PF*.
2)	A dc chopper is used in rheostatic braking of a dc series motor. The armature resistance is R_a=0.02 Ω and the field resistance is R_f= 0.04 Ω. The braking resistor, R_b =5 Ω. The back emf constant of the motor is K_v=12 mV/A-rad/s. The average armature current, I_a=350A. The armature current is continuous and ripple-free. If the duty cycle of chopper is 50%. Determine: (a) Average voltage across the chopper, V_{ch} (b) Power dissipated in the resistor, P_b; (c) Equivalent load resistance of the motor acting as a generator, R_{eq}; (d) Motor speed; and (e) Peak chopper voltage, V_p.

Question - 5	**20 points**
1)	For an induction machine operated with asymmetrical voltage source, answer the following questions: (a) Define the voltage-unbalanced factor, and what is the recommendation of IEEE-519 standard about this factor? (b) Analyze the performance of the system in terms of: (i) The machine equivalent circuit, (ii) Toque-speed characteristics, (iii) Starting torque, (iv) Rotor current, (v) Machine losses and efficiency. *Remark: Your answer should supported with suitable graphs and equations.*

2) For an induction machine operated with non-sinusoidal supply, answer the following questions:

(a) Define the voltage-distortion factor, and what is the recommendation of IEEE-519 standard about this factor?

(b) State true (√) or false (×) and correct the false statements

(i) The pulsating torque is obtained due to interaction between the RMF in the air-gap by one harmonic component with the stator current of another harmonic.

(ii) The most significant harmonic torque is produced by the interaction between the stator fundamental flux and the rotor harmonic currents.

(iii) The torque resulting

(iv) Toque-speed characteristics,

(v) Starting torque,

(vi) Rotor current,

(vii) Machine losses and efficiency.

3) A 2.8 kW, 400 V, 50 Hz, 4 pole, 1370 rpm, delta connected class-D squirrel-cage induction motor fed from an ac-voltage controller, answer the following questions:

1- Draw the schematic-diagram and the torque-speed characteristics of this configuration for four-quadrant operation and guess the operating switches in each quarter?

2- Why the speed control method based on this configuration is suitable for this motor class and for applications where torque demand reduces with speed? Your answer should supported with suitable graphs and equations.

3- Draw the block-diagram for closed-loop scheme for single-quadrant speed-control based on this configuration?

4- What are the major applications of this configuration?

5- If the motor parameters referred to the stator circuit are:

$R_s = 2\ \Omega$ $R_r = 5\ \Omega$ $X_s = X_r = 5\ \Omega$ $X_m = 80\ \Omega$

When driving a fan load it runs at rated speed at rated voltage. Calculate:

i) Motor terminal voltage, current and torque at 1200 rpm.

ii) Motor speed, current and torque for terminal voltage of 300 V.

Question - 6 **10 points**

1) A three-phase induction motor is controlled by V/Hz open-loop scheme. The drive is designed for a speed range from twice-synchronous speed to standstill.

1- Draw the block-diagram of the drive system.

2- Sketch the torque-speed characteristics for the following cases (in one graph):

- Operating frequency equals half of the rated frequency,
- Operating frequency equals the rated frequency,
- Operating frequency equals one and half of the rated frequency, and
- Operating frequency equals twice of the rated frequency.

2)	a) What is scalar control of motors? What are a few drawbacks of scalar control? Why would one choose field oriented control over scalar control? b) Drive the basic equations for indirect rotor field oriented control (IRFOC). c) Draw the block-diagram of an IRFOC control of three-phase induction motor based on the space vector pulse-width-modulated three-phase voltage source inverter.

Wish you all the best

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