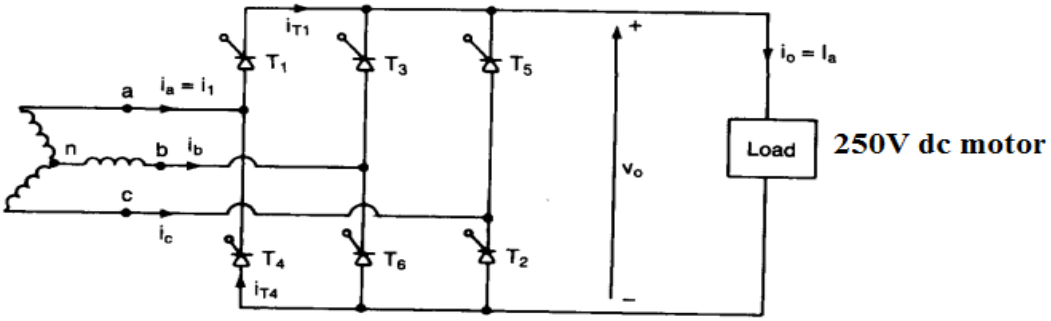
International Islamic University Chittagong
Department of Electrical and Electronic Engineering

Final Examination Spring-2020	Program: B.Sc. Engg. (EEE)
Course Code: **EEE-4705**	Course Title: **Power Electronics**
Time: **5 hours** (Writing - **4 hours 30 minutes** + **30 minutes** submission time)	Full Marks: **50** (**Written** 30 + **Viva/Viva-Quiz**-20)

[Answer **each of the** questions from the followings; Figures in the right margin indicate full marks. **Answer script must be submitted through online method within 5 hours from starting time. Also, write down the Q. Set on the front page of your answer script]**

Q. Set-A

1(a).	Suppose, a factory of Bangladesh Steel Re-Rolling Mill (BSRM) Ltd. is electrified from a 3-Φ AC distribution system, and in that factory, you would like to control the speed of a variable speed DC motor of 1 MW capacity by controlling the voltage supply. Now, for this purpose, **design** a converter which will have more than two quadrant operation (only draw circuit diagram and necessary waveforms).	**CO2**	**C**	**02**
1(b).	Consider a DC motor drive of KYCR Ltd. which is supplied from a 3-Φ AC distribution system of Y-connected 223V, 50 Hz supply by a means of a 3-Φ controlled rectifier as shown in **Fig. 1** and a 250V DC motor is connected as a load of that converter. Also consider that motor load resistance is R= ***(M+3)*** Ω where ***M*** is equal to the **last digit of your Matric ID**. (i) What will be the delay angle of that converter, if you want to run that motor at its maximum speed? Also, Estimate the rectification efficiency of the converter at that delay angle. (ii) What will be the range of delay angle at which that motor will be damaged?  **Fig. 1**	**CO3**	**C**	**04**
2(a).	"A chopper can be considered as dc equivalent to an AC transformer with a continuously variable turns ratio"- **justify** the statement.	**CO3**	**An**	**01**
2(b).	Recently, several European countries like Sweden are thinking about DC distribution grid system for convenience in Electric Vehicle (EV) charging. For this purpose switch mode DC regulator is an important tool. Now, **design** a converter circuit for obtaining regulated DC output voltage of dual polarity from an unregulated DC supply voltage. You may consider IGBT as electronic switch. Also, **Establish** a relationship among input voltage, duty cycle, and output voltage showing mathematical expression and waveforms.	**CO3**	**C**	**03**
2(c).	Consider that a grid-connected solar panel is using a DC Boost chopper which has an input voltage of *Vs* = ***(M+2)*** V. The average output voltage V_a = ***(M+5)*** V and	**CO2**	**C**	**02**

	the average load current I_a = 0.4A where ***M*** is equal to the **last digit of your Matric ID.** The switching frequency is 20kHz. If L = 145µH and C = 215µF, **Determine** (a) the ripple voltage of filter capacitor ΔV_C and (b) the critical value of C.			
3(a).	Suppose you would like to harvest renewable energy (RE) for solving load shedding problem of your village and you want to install a grid-connected PV system for continuous power supply in that village which is electrified from a 1-Φ AC distribution system. Now, **Design** a power electronic circuit for integration of RE sources with the power grid. Also, Briefly **explain** the principle of operation with necessary waveforms and **derive** the equation of output voltage of your designed circuit. Also, briefly explain how you can control the output voltage of that designed circuit to ensure power system stability?	**CO3**	**C**	**04**
3(b).	Consider a 3-Φ, Y-connected variable speed induction motor drive of RSRM Ltd. is supplied from a fuel cell stuck with 205 V capacity by a means of a 3-Φ bridge inverter. The inverter frequency is f_0 = 60 Hz. Also, consider the load of that inverter is equivalent to a Resistance, R= ***(M+3)*** Ω and inductance, L = ***(M+12)*** mH , where ***M*** is equal to the **last digit of your Matric ID**. Now, **Determine** (a) the THD, and (b) the load power, P_0,	**CO2**	**C**	**02**
4(a).	**Design** a single phase cycloconverter circuit whose output frequency will be 15Hz. Also modify it to get output frequency 18Hz.[Consider that supply frequency is 90Hz]	**CO3**	**C**	**03**
4(b).	Consider a 1-Φ variable speed AC motor drive of an industry is powered by a 1-Φ half-wave AC voltage controller with the input voltage of Vs = 210 V (R.M.S), 50Hz. Also, consider the load of that converter is equivalent to a Resistance, R = ***G*** Ω, where ***G*** is equal to **last two-digit of your Matric ID**. The delay angle of Thyristor T_1 is equal: $\alpha = \pi/2$. **Determine** the input power factor PF.	**CO2**	**E**	**01**
4(c).	Suppose your location electrified from an AC distribution system, and you would like to control the speed of a high power variable speed synchronous motor drive by controlling the voltage supply. Now, **Design** a commonly used converter circuit for ensuring controllable voltage supply for this high power motor drive (Show only circuit diagram).	**CO3**	**C**	**02**
5(a).	Suppose you would like to control the speed of a separately excited DC motor drive of a factory of KYCR Ltd. by a 1-Φ semiconverter. The field circuit is also controlled by a full converter and the field current is set to the maximum possible value. The AC supply voltage to the armature and field converters is 1-Φ, 230V, 50 Hz. The armature resistance is R_a = ***0.1*×*M*** Ω, the field circuit resistance is R_f = ***2M*** Ω, and the motor voltage constant is K_v = 1.3V/A-rad/s. The average armature current corresponding to load demands is I_a = ***M*** A. The viscous friction and no-load losses are negligible. The armature current is continuous and has negligible ripple. If the delay angle of the armature converter is α_a = ***M*** degree, where ***M*** is equal to **last two-digit of your Matric ID. Determine**… (a) the motor speed, ω .	**CO2**	**C**	**02**
5(b).	Suppose you would like to control a DC motor drive using computerized system. Now, briefly explain how a DC drive can be controlled using computerized system.	**CO1**	**Ap**	**02**
5(c).	Suppose a factory of S. Alam group is electrified from an AC distribution system, and you would like to control a synchronous motor drive. Briefly explain the basic principle of control technique for that purpose.	**CO3**	**C**	**02**

6.	Viva/Viva-Quiz: The time of viva/viva-quiz will be declared in google classroom.			**20**