Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

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A Constituent Institution of Manipal University

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: SOLID STATE LIGHTING & CONTROLS [ELE 451]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 06 December 2016** **MAX. MARKS: 50**

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitable assumed.

1A. A boost converter based LED driver topology with D=0.72, L =20µH, C_O=480µF, RC_{ESR}=8mΩ RLED=6 ohms, ILED=3A, VLED=18V, switching frequency = 200kHz i) obtain the power stage transfer function for current mode control ii) Type II compensator transfer function, and values of R&C, take R corresponds to cross over frequency as 930kΩ iii) draw the closed loop circuit schematic with compensation. Clearly mention the design rules of compensator. ***(08)***

1B. Explain slope compensation for current mode control with neat diagrams ***(02)***

2A. Prove from fundamentals that light power escape from the LED structure is identical to the light power in air. ***(04)***

2B. Explain the role of extraction efficiency of LED luminaire and mention the methods to improve it. What is meant by life cycle of photon? ***(04)***

2C. The Refractive index of GaAs, GaN and light emitting polymers are 3.4, 2.5 and 1.5 respectively. Calculate the critical angle of Total internal reflection (TIR) for GaAs, GaN and for polymers. ***(02)***

3A. Four LED samples with color chromaticity coordinates and lumen output specifications are given in table 1. Obtain the color chromaticity coordinates and lumen output of light mixing without dimming.

Table 1. LED sample specifications

LED	x	y	Y(ϕ)lm
1	0.42	0.385	87
2	0.46	0.395	74
3	0.475	0.425	74
4	0.43	0.415	87

(04)

3B. Explain the following i) Binning ii) Mc Adam Ellipse highlighting its significance on color mixing and white light generation. ***(04)***

3C. Discuss lumen maintenance of LED lamps and LM 80 standard ***(02)***

4A. Draw the thermal resistance model of LED luminaire and describe the factors to be considered for the design and selection of heat sink. ***(04)***

4B. Mention the advantages of any one configuration schemes used for connecting multiple LEDs ***(02)***

4C. Explain the color stability compensation of RGB LED luminaire with a neat block diagram. ***(04)***

5A. Calculate the number of LEDs required for the design of a luminaire with light output 2000lm with optical efficiency 90% and thermal efficiency 85%. Use LEDs at 5000K CCT with minimum luminous flux of 122lm @350mA. ***(03)***

5B. A fixture with 7 LEDs connected in parallel is to be used for designing general lighting luminaire with proper heat management technique. Determine the thermal resistance specification from heat sink to air to ensure maximum ambient and junction temperature of 50˚C and 140˚C. Given LED data Vf = 3.3V, If = 350mA, Rth(Tj-sp) = 7˚C/W and Rth(sp-hs) = 1˚C/W. ***(04)***

5C. Explain pulse width modulation dimming of LED luminaires. ***(03)***

6A. Design the values of inductor and capacitor for a buck boost based LED driver circuit for the following specifications.

Input voltage – (6-16)V

LED string voltage range – 12V

LED drive current – 1A

Ripple current – 10%

Desired efficiency – 95%

Switching frequency 300 kHz

Voltage ripple - 8% ***(04)***

6B. RGB color mixing is applied to get the white point chromaticity coordinates x=0.35 and y=0.33. RGB LED samples chromaticity coordinates are given in Table 2. Determine the percentage duty cycle for RGB LEDs to obtain the desired white point.

Table 2. chromaticity coordinates

LED	x	y
R	0.6763	0.3237
G	0.2088	0.7408
B	0.1405	0.0391

(04)

6C. Describe the features of DALI for solid state lighting controls. ***(02)***