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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION

SEPTEMBER 2013 SESSION

SUBJECT CODE	:	**FLB 20102**
SUBJECT TITLE	:	**OP-AMP & NON LINEAR CIRCUITS**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	**2.5 HOURS**
DATE	:	

INSTRUCTIONS TO CANDIDATES

1. **Please read the instructions given in the question paper CAREFULLY.**
2. **This question paper is printed on both sides of the paper.**
3. **Please write your answers on the answer booklet provided.**
4. **Answers should be written in blue or black ink except for sketching, graphic and illustration.**
5. **This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer three (3) questions only.**
6. **Answer all questions in English.**

THERE ARE 7 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

(a) Define and briefly explain the doping process. (3 marks)

(b) Describe the conditions established by forward and reverse-bias states of the PN-junction diode.

(4 marks)

(c) Draw an ideal and practical pn-junction diode characteristic curve. (3 marks)

Question 2

Considering silicon diode, determine current I, voltage across the diode (V_D), voltage drop across R_1 (V_1) and output voltage (V_{OUT}).

(10 marks)

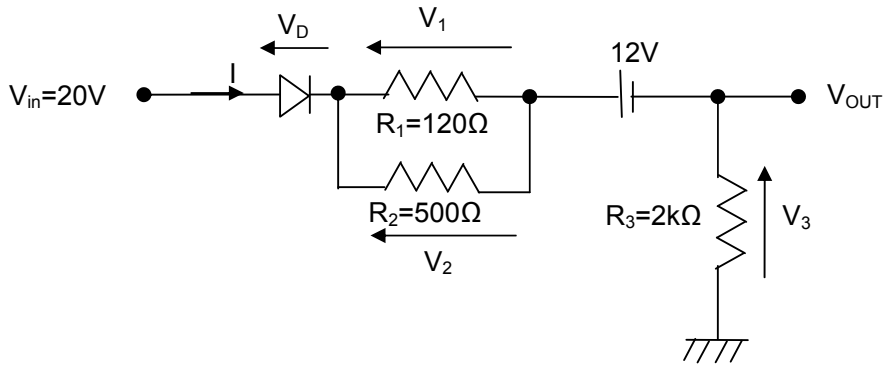


Figure 1

Question 3

Figure 2 shows a clipper circuit using two ideal silicon zener diodes with its respected output voltage, V_{OUT}. For both question (a) and (b), please refer to data sheet attached in **Appendix I** and determine:

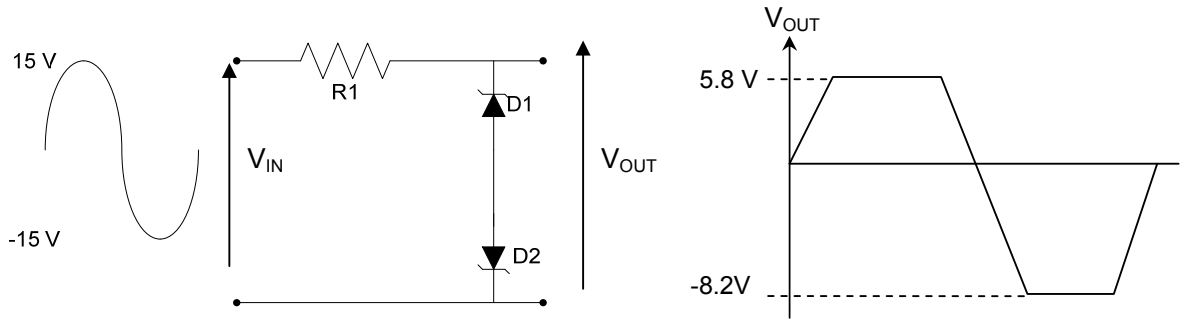


Figure 2

(a) The device type number of zener diode D_1 and D_2. Support your answer with calculation.

(6 marks)

(b) The parameters value and unit for answer in (a).

(i) maximum DC Power Dissipation ($\mathbf{P_D}$) (1 marks)

(ii) nominal Zener Voltage ($\mathbf{V_Z}$) (1 marks)

(iii) zener Knee Current ($\mathbf{I_{ZK}}$) (1 marks)

(iv) maximum Zener Test Impedance ($\mathbf{Z_{ZT}}$) (1 marks)

Question 4

A high sensor water module in **Figure 3** below uses a bipolar junction transistor to energize and operate a $12V_{DC}$ relay. The operation of the circuit is as follows: When sensor detects water, switch is closed and the transistor shall turn 'ON'. The relay then will be energized. Given $\beta = 60$, determine I_B, I_C, I_E, V_{BE}, V_{CE} and V_{CB}. (Transistor based on silicon).

(10 marks)

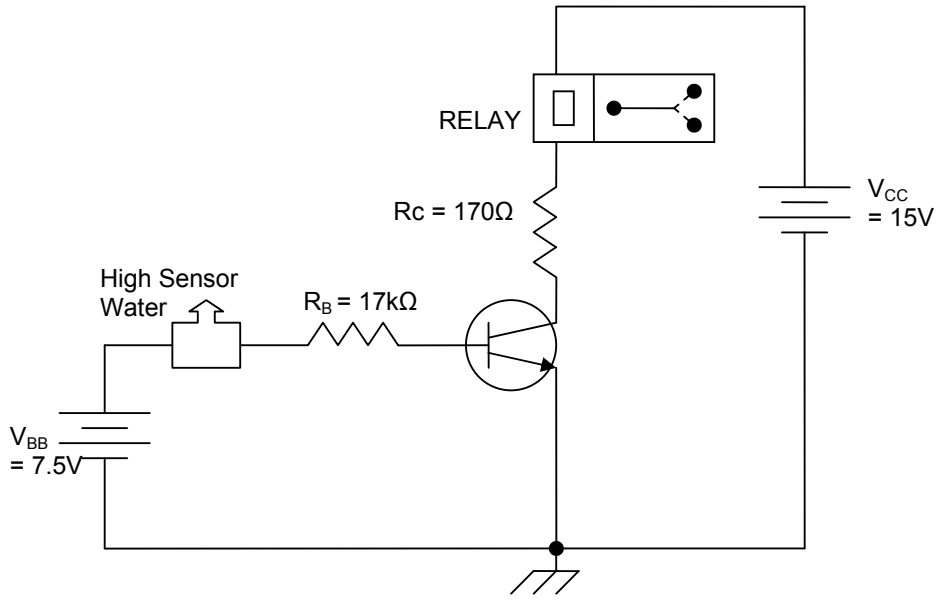


Figure 3

SECTION B (Total: 60 marks)

INSTRUCTION: Answer THREE (3) questions only.

Question 5

A positive full wave bridge rectifier is shown in **Figure 4**. Assume only silicon diodes are used in the rectifier. The turns ratio of the transformer is 10:1. Given input voltage is 115Vrms 60Hz. Answer the following questions.

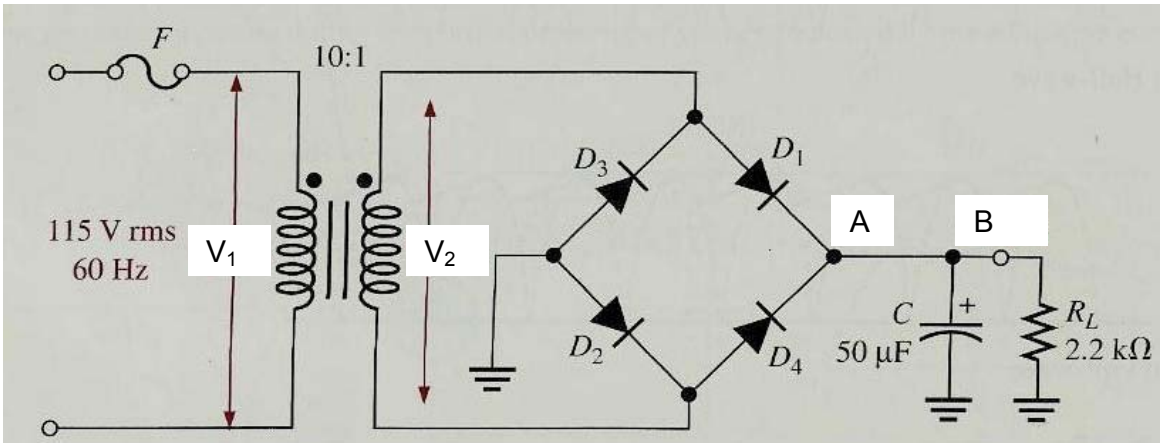


Figure 4

(a) State two (2) advantages of bridge rectifier circuit. (2 marks)

(b) Explain the operation of the circuit. (6 marks)

(c) Calculate:

(i) The peak load current, I_{Lp}. (4 marks)

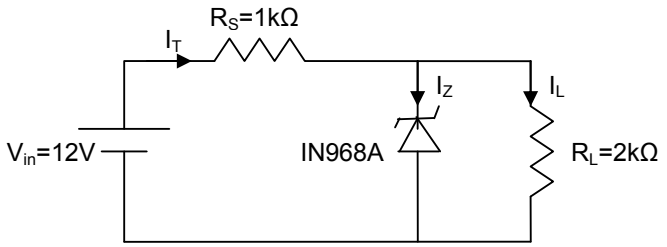
(ii) The average load current, I_{Lavg}. (4 marks)

(iii) Sketch the expected output waveform at point A and point B. (4 marks)

Question 6

(a) (i) By referring to the zener voltage regulator circuit shown in **Figure 5**, calculate I_Z. (Consider ideal zener diode).

(8 marks)



IN968A Parameters:
V_Z = 4.2V
I_{ZK} = 0.2mA
I_{ZT} = 15mA
P_{Dmax} = 210mW

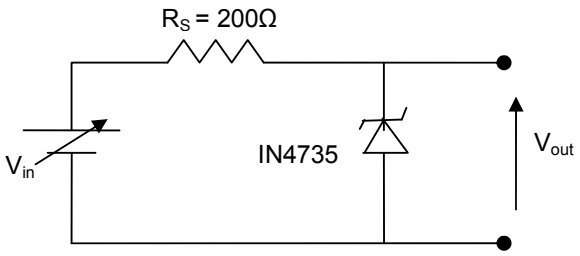
Figure 6

(ii) Determine whether zener diode IN968A used in circuit in **Figure 5** can maintain its regulation. Give your reason for your answer.

(2 marks)

(b) By considering ideal zener diode, determine the minimum and maximum input voltages that can be regulated by the zener diode in **Figure 6** below.

(10 marks)



IN4735 Parameters:
V_Z = 6V at I_{ZT} = 20mA
I_{ZK} = 2mA
P_D = 1W at T_L = 50˚C

Figure 6

Question 7

(a) List out three (3) types of BJT circuit configurations. (3 marks)

(b) **Figure 7** shows silicon BJT in saturation condition and acts as a "fully ON" switch. List out four (4) saturation characteristics.

(4 marks)

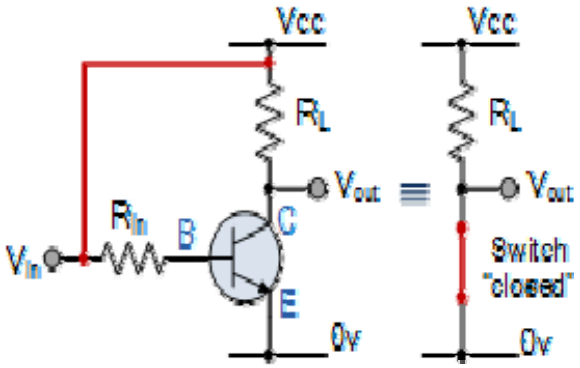


Figure 7

(c) (i) Given the information appearing in **Figure 8**, determine I_C, R_C, R_B and V_{CE}. Consider germanium based BJT.

(11 marks)

(ii) Find the saturation current I_{Csat} for the same circuit configuration.

(2 marks)

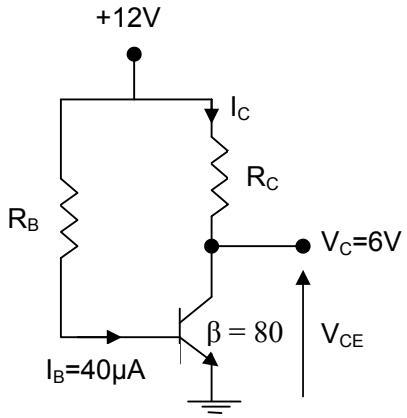


Figure 8

Question 8

(a) Prove that the closed-loop gain for non-inverting amplifier is $A_{CL} = 1 + \frac{R_2}{R_1}$

(6 marks)

(b) By using LM741 and its data sheets attached in **Appendix II**,

(i) Design an inverting amplifier that will deliver a $12V_{pp}$ output voltage to a 15kΩ load resistance with a $50mV_{pk}$ input voltage and maximum amplification is $30V_{pp}$. (Include the 8-pin DIP pin numbers in your schematic diagram).

(8 marks)

(ii) Determine the maximum allowable input voltage, V_{INmax}.

(2 marks)

(iii) Sketch V_{IN} and V_{OUT} on the same curve.

(4 marks)

END OF QUESTION PAPER

APPENDIX I

FAIRCHILD SEMICONDUCTOR®

January 2005

1N4728A - 1N4764A

Zeners

DO-41 Glass case
COLOR BAND DENOTES CATHODE

Absolute Maximum Ratings *

T_a = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
P_D	Power Dissipation @ TL ≤ 50°C, Lead Length = 3/8"	1.0	W
	Derate above 50°C	6.67	mW/°C
T_J, T_{STG}	Operating and Storage Temperature Range	-65 to +200	°C

* These ratings are limiting values above which the serviceability of the diode may be impaired.

Electrical Characteristics

T_a = 25°C unless otherwise noted

Device	V_Z (V) @ I_Z (Note 1)			Test Current I_Z (mA)	Max. Zener Impedance			Leakage Current	
	Min.	Typ.	Max.		Z_Z @ I_Z (Ω)	Z_{ZK} @ I_{ZK} (Ω)	I_{ZK} (mA)	I_R (μA)	V_R (V)
1N4728A	3.315	3.3	3.465	76	10	400	1	100	1
1N4729A	3.42	3.6	3.78	69	10	400	1	100	1
1N4730A	3.705	3.9	4.095	64	9	400	1	50	1
1N4731A	4.085	4.3	4.515	58	9	400	1	10	1
1N4732A	4.465	4.7	4.935	53	8	500	1	10	1
1N4733A	4.845	5.1	5.355	49	7	550	1	10	1
1N4734A	5.32	5.6	5.88	45	5	600	1	10	2
1N4735A	5.89	6.2	6.51	41	2	700	1	10	3
1N4736A	6.46	6.8	7.14	37	3.5	700	1	10	4
1N4737A	7.125	7.5	7.875	34	4	700	0.5	10	5
1N4738A	7.79	8.2	8.61	31	4.5	700	0.5	10	6
1N4739A	8.645	9.1	9.555	28	5	700	0.5	10	7
1N4740A	9.5	10	10.5	25	7	700	0.25	10	7.6
1N4741A	10.45	11	11.55	23	8	700	0.25	5	8.4
1N4742A	11.4	12	12.6	21	9	700	0.25	5	9.1
1N4743A	12.35	13	13.65	19	10	700	0.25	5	9.9
1N4744A	14.25	15	15.75	17	14	700	0.25	5	11.4
1N4745A	15.2	16	16.8	15.5	16	700	0.25	5	12.2
1N4746A	17.1	18	18.9	14	20	750	0.25	5	13.7
1N4747A	19	20	21	12.5	22	750	0.25	5	15.2

APPENDIX II

National Semiconductor

November 1994

LM741 Operational Amplifier

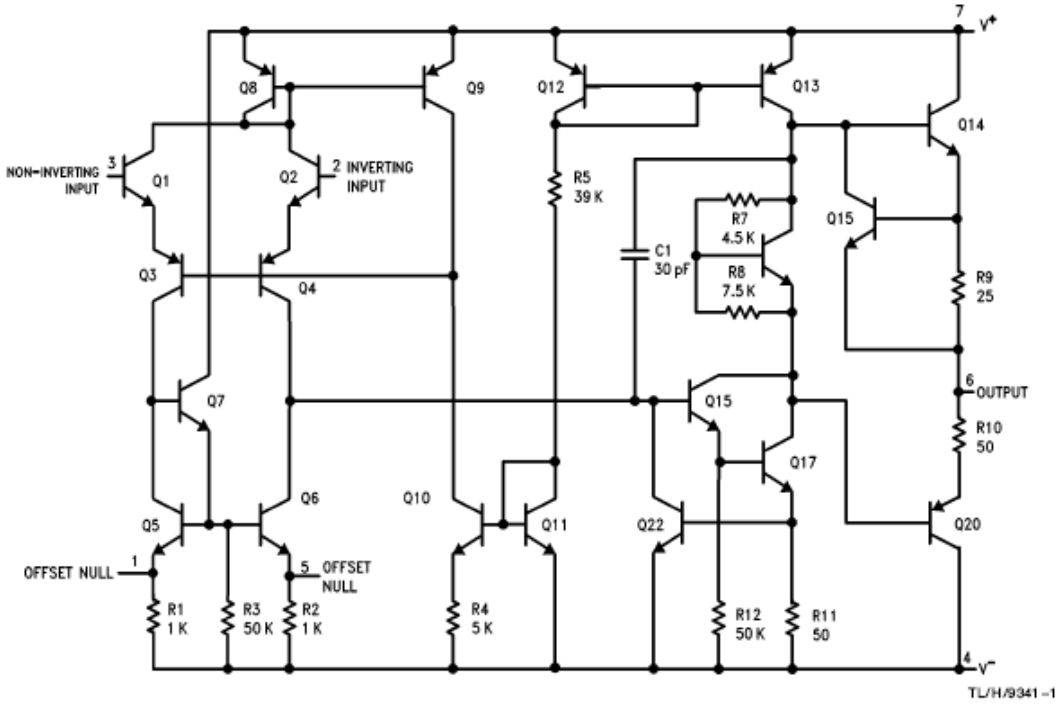
General Description

The LM741 series are general purpose operational amplifiers which feature improved performance over industry standards like the LM709. They are direct, plug-in replacements for the 709C, LM201, MC1439 and 748 in most applications.

The amplifiers offer many features which make their application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, as well as freedom from oscillations.

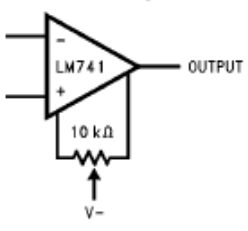
The LM741C/LM741E are identical to the LM741/LM741A except that the LM741C/LM741E have their performance guaranteed over a 0°C to +70°C temperature range, instead of −55°C to +125°C.

Schematic Diagram



TL/H/9341–1

Offset Nulling Circuit



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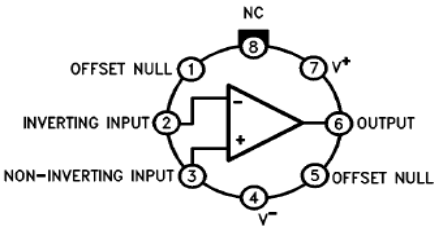
Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.
(Note 5)

	LM741A	LM741E	LM741	LM741C
Supply Voltage	±22V	±22V	±22V	±18V
Power Dissipation (Note 1)	500 mW	500 mW	500 mW	500 mW
Differential Input Voltage	±30V	±30V	±30V	±30V
Input Voltage (Note 2)	±15V	±15V	±15V	±15V
Output Short Circuit Duration	Continuous	Continuous	Continuous	Continuous
Operating Temperature Range	−55°C to +125°C	0°C to +70°C	−55°C to +125°C	0°C to +70°C
Storage Temperature Range	−65°C to +150°C	−65°C to +150°C	−65°C to +150°C	−65°C to +150°C
Junction Temperature	150°C	100°C	150°C	100°C
Soldering Information				
N-Package (10 seconds)	260°C	260°C	260°C	260°C
J- or H-Package (10 seconds)	300°C	300°C	300°C	300°C
M-Package				
Vapor Phase (60 seconds)	215°C	215°C	215°C	215°C
Infrared (15 seconds)	215°C	215°C	215°C	215°C
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.				
ESD Tolerance (Note 6)	400V	400V	400V	400V

Connection Diagrams

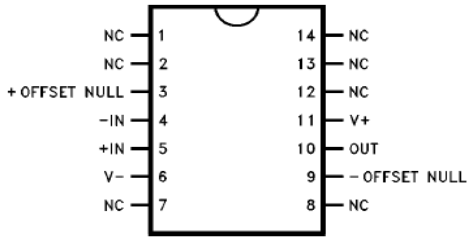
Metal Can Package



TL/H/9341–2

Order Number LM741H, LM741H/883*, LM741AH/883 or LM741CH
See NS Package Number H08C

Ceramic Dual-In-Line Package

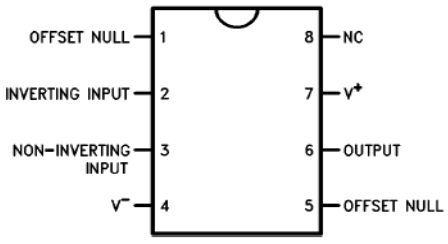


TL/H/9341–5

Order Number LM741J-14/883*, LM741AJ-14/883**
See NS Package Number J14A

*also available per JM38510/10101
**also available per JM38510/10102

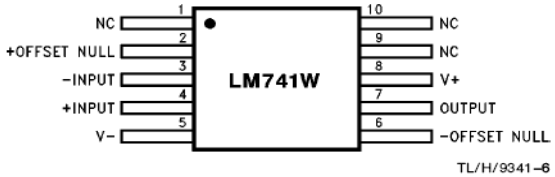
Dual-In-Line or S.O. Package



TL/H/9341–3

Order Number LM741J, LM741J/883, LM741CM, LM741CN or LM741EN
See NS Package Number J08A, M08A or N08E

Ceramic Flatpak



TL/H/9341–6

Order Number LM741W/883
See NS Package Number W10A