ECE 320: Quiz #5 Name

Transistors, AC to DC Converters - October 6, 2016

1) The VI characteristics for an NPN transistor are shown below.

- Label on this graph the off / active / saturated regions.
- Determine the current gain, β

off / active / saturated revions	Current Gain		
show on graph	20		



2)	Draw the	load-line	for the o	circuit below.	From the	graph,	determine	the ()-point
									< I

Load Line	Q-Point		
	Vce	Ice	
Show on graph	1.4V	86mA	



3) Determine the voltages and currents for the following H-bridge. Assume all transistors are ideal silicon transistors with Vf = 0.7V and $\beta = 100$

I1	V2	V3	I4
930uA	9.8V	5.24V	456uA
	saturated	4.56V less than V2	What limits Ic

 $I_c = \min(93mA, 96mA, 45.6mA)$



4) Assume a full-wave rectifier with two SCR's and five diodes (total). Determine the DC (average) signal for a firing angle of 60 degrees:

$$V_{avg} = \frac{1}{\pi} \int_{\pi/3}^{\pi} 18.6 \cdot \sin{(t)} \cdot dt$$

Vavg = 8.88V

$$V_{avg} = \frac{1}{\pi} \int_{\pi/3}^{\pi} 18.6 \cdot \sin(t) \cdot dt$$
$$V_{avg} = \frac{18.6}{\pi} \cdot (-\cos(t))_{\pi/3}^{\pi}$$
$$V_{avg} = \frac{18.6}{\pi} \left(1 + \cos\left(\frac{\pi}{3}\right)\right)$$
$$V_{avg} = \frac{18.6}{\pi} (1 + 0.5)$$

5) A 60Hz 20Vp sine wave drives the following full-wave rectifier with a firing angle of 60 degrees. Determine the peak-to-peak ripple at V1, V2 without C, and V2 with C

V1pp	Frequency of the ripple at V2	V2pp (C = 0)	V2pp (C = 250uF)
18.6V _{pp}	120Hz	4.93V _{pp}	$261 mV_{pp}$
	754 rad/sec		

The impedance of L and C are:

$$Z_L = j\omega L = j \cdot 754 \cdot 0.5H = j377\Omega$$
$$Z_c = \frac{1}{j\omega C} = \frac{1}{j \cdot 754 \cdot 250uF} = -j5.3\Omega$$

If C = 0, the ripple drops by the ration of R to L

$$V_{2pp} = \left(\frac{100\Omega}{377\Omega}\right) 18.6V_{pp} = 4.93V_{pp}$$

With C, the ripple drops again by the ratio of C to R

$$V_{2pp} = \left(\frac{5.3\Omega}{100\Omega}\right) 4.93 V_{pp} = 261 m V_{pp}$$



Exact Approximate Solution:

$$V_{2pp} = \left(\frac{R}{R+j\omega L}\right) V_{1pp}$$
$$V_{2pp} = \left(\frac{100}{100+j377}\right) 18.6 V_{pp}$$
$$V_{2pp} = 4.77 V_{pp}$$

(vs. 4.93Vpp on the previous page)

$$V_{2pp} = \left| \frac{R ||Z_c}{R ||Z_c + Z_L} \right| V_{1pp}$$

$$V_{2pp} = \left| \frac{100 ||-j5.3}{100 ||-j5.3 + j377} \right| 18.6 V_{pp}$$

$$V_{2pp} = \left| \frac{(0.28 - j5.28)}{(0.28 - j5.28) + j377} \right| 18.6 V_{pp}$$

$$V_{2pp} = (0.0142) 18.6 V_{pp}$$

$$V_{2pp} = 265 m V_{pp}$$

(vs. 261mVpp on the previous page)

Bernie Sanders Trivia!!! Can College be made free?

NDSU's budget in 2014 was \$407 million. What percentage of this budget goes towards teaching in the various academic departments?

That's kind of difficult to say. The NDSU Annual Budget for 2014 breaks the expenses at NDSU into 8,700 different categories. The total for all expenditures is \$407 million¹. The NDSU Biennial Budget lists the Operating Expenses as \$256.7 million. It's more than a little disconcerting that the two numbers differ by \$156 million - and I'm not sure which set of numers to use. The NDSU Annual Budget is more detailed, however, and works better for answering this question. So, let's use the NDSU Annual Budget numbers (\$407 million).

Group these 8700 categories into the 7 groups:

- Athletics: Athletic administration, fund raising, weight rooms, other Department 1200 activities
- Academic Departments: ECE, Mechanical, Math, etc. Where the teaching budget is located.
- Administration: Deans, VPs, HR, purchasing, etc.
- Student Services: Wellness Center, Health Center, Center for Writers, ...
- Facilities: Facilities maintenance, Police, Parking, IT Services
- Dorms: Residence Life, Dining Services
- Other: Library, Bookstore

	budget (millions)	%
facilities	139.43	34.2
academic departments	90.91	22.3
administration	70.45	17.3
dorms	41.44	10.2
other	34.79	8.5
athletics	17.81	4.4
student services	12.49	3.1
Total	407.31	100

This number, 22.3%, is slightly inflated:

- Department chairs are administrators but are paid out of the department budget.
- Department staff are paid out of the department budget (which is probably fair since they have a considerable amount of interaction with students), and
- Faculty are also typically have a 40% teaching / 40% research / 20% service component

Likewise, not all the money going to the academic departments goes towards teaching.

Revenue is listed in the Biennial Budget² - which differs by 156 million from the Annual Budget. So it's hard to compare these two reports. The revenue listed is

- \$96.8 million: Tuition and Fees:
- \$48.2 million: State Appropriations
- \$45.2 million: Sales and Services
- \$43.3 million: Federal Grants
- \$17.6 million: Other Contracts
- \$6.3 million: Other

Ignoring the \$156 million difference, this says: "If you want to eliminate tuition and fees, you'd have to reduce the budget by \$96.8 million (or find \$96.8 million in alternate funding)."

1

https://www.ndsu.edu/fileadmin/vpfa/reports/budget/NDSU_Budget_FY2014.pdf