

## Project #1\aver.m

```
1 % ID Number: 229,506
2 % ECE 31033 - Project #1
3 % aver.m
4
5 % The fourth file (aver.m) contains a function you create to compute the average of
6 % a waveform. Specifically, the function is of the form
7 %     function av = aver(x,T,dt)
8 % where x is the waveform to be averaged, T is its period, and dt is the period of time
9 % between samples. This function must use the last period of the input waveform to
10 % calculate the average.
11
12 function av = aver(x, T, dt)
13     location = length(x);
14     av = 0;
15     time = 0;
16
17     while (time <= T)
18         av = av + dt * (x(location));
19         time = time + dt;
20         location = location - 1;
21     end
22
23     av = av / T;
24 end
25
```

## Project #1\sw.m

```
1 % ID Number: 229,506
2 % ECE 31033 - Project #1
3 % sw.m
4
5 % The first file (sw.m) contains a function (sw) that accepts the duty cycle D, and a
6 % single instant of time as an input, and outputs the state (on/off) of the transistor
7 % at that time instant as an output. A Fourier series-based triangle wave that you
8 % create within this function should be compared with the duty cycle D to
9 % determine the state of the transistor. The output of the function is a 1 if the
10 % transistor is to be turned on. It is a value of 0 if it is turned off.
11
12 function state = sw(D, t)
13     T_sw = 1 / 10000;
14
15     w = 2 * pi / T_sw;
16
17     a_k = 0;
18     triangle_wave = 0.5;
19
20     N = 200; % Number of Fourier terms.
21
22     k = 1;
23     while k <= N
24         z = k * w * T_sw; % Temporary variable; to simplify code for the coefficient.
25
26         a_k = (2 * (4 * cos(0.5 * z) - 2 * cos(z) - 2)) / (z^2);
27         triangle_wave = triangle_wave + a_k * cos(k * w * t);
28         k = k + 1;
29     end
30
31     if D >= triangle_wave
32         state = 1;
33     else
34         state = 0;
35     end
36 end
```

## Project #1\buck.m

```
1 % ID Number: 229,506
2 % ECE 31033 - Project #1
3 % buck.m
4
5 % The file (buck.m) contains the Forward Euler integration algorithm within a while
6 % loop (FOR LOOPS ARE NOT ALLOWED). buck is not a function. The file buck.m only
7 % contains a single while loop (i.e. while (t(k)<tend)) to solve for all circuit voltages
8 % and currents of your buck converter. Within the while loop, you will call the
9 % function sw at each time instant to determine the value of your transistor gate
10 % (on or off). Voltages of currents and voltages of circuit components must be
11 % determined within the while loop.
12 while t_vec(k) < tend
13     if (ideal_boolean) % If the circuit is ideal.
14         switch_state(k) = sw(D, t_vec(k)); % calling sw.m
15
16         % Inductor Current and Load Voltage Calculation
17         i_L_vec(k+1) = i_L_vec(k) + dt * ((switch_state(k)) * V_in - V_load_vec(k)) / L;
18         V_load_vec(k+1) = V_load_vec(k) + dt * ((i_L_vec(k) - (V_load_vec(k) / R_load)) / C);
19
20         % Switch 1 and 2: Voltage and Current Calculations
21         if(switch_state(k))
22             V_switch1(k+1) = V_in;
23             i_switch1(k+1) = i_L_vec(k+1) * switch_state(k);
24
25             V_switch2(k+1) = 0;
26             i_switch2(k+1) = 0;
27
28             V_L_vec(k+1) = V_in - V_load_avg;
29         else
30             V_switch1(k+1) = 0;
31             i_switch1(k+1) = 0;
32
33             V_switch2(k+1) = -1 * V_in;
34             i_switch2(k+1) = i_L_vec(k) * (1 - switch_state(k));
35
36             V_L_vec(k+1) = -1 * V_load_avg;
37         end
38
39         % Capacitor: Voltage and Current Calculations
40         i_C_vec(k+1) = i_L_vec(k) - (V_load_vec(k) / R_load);
41         V_C_vec(k+1) = V_load_vec(k+1);
42
43         % Load: Current Calculation
44         i_load_vec(k+1) = V_load_vec(k+1) / R_load;
45
46     else % If the circuit is non ideal.
47         switch_state(k) = sw(D_non_ideal, t_vec(k)); % calling sw.m
48
49         if(switch_state(k))
50             i_L_vec(k+1) = i_L_vec(k) + dt * ((V_in - V_T_on - V_load_vec(k) - (R_T_on *
i_L_vec(k)))) / L; %i_L
```

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51     i_L_vec(k+1) = i_L_vec(k) + dt * ((V_in - V_T_on - V_load_vec(k) - (R_T_on *
i_L_vec(k))) / L);    %i_L
52
53     % Switch 1: Voltage and Current Calculations
54     V_switch1(k+1) = 0;
55     i_switch1(k+1) = i_L_vec(k+1);
56     P_switch1(k+1) = (R_T_on * i_L_vec(k+1) + V_T_on) * i_L_vec(k+1);
57
58     % Switch 2: Voltage and Current Calculations
59     V_switch2(k+1) = V_D_on + (R_D_on * i_L_vec(k+1)) - V_in;
60     i_switch2(k+1) = 0;
61     else
62     i_L_vec(k+1) = i_L_vec(k) + dt * ((-1 * V_load_vec(k) - V_D_on - (R_D_on *
i_L_vec(k))) / L);
63
64     % Switch 1: Voltage and Current Calculations
65     V_switch1(k+1) = V_in + (R_D_on * i_L_vec(k+1)) + V_D_on;
66     i_switch1(k+1) = 0;
67
68     % Switch 2: Voltage and Current Calculations
69     V_switch2(k+1) = 0;
70     i_switch2(k+1) = i_L_vec(k+1);
71     P_switch2(k+1) = (R_D_on * i_L_vec(k+1) + V_D_on) * i_L_vec(k+1);
72     end
73
74     V_load_vec(k+1) = V_load_vec(k) + dt * ((i_L_vec(k) - (V_load_vec(k) / R_load)) / C);
%V_load
75     end
76
77     % Increment the time and index
78     t_vec(k + 1) = t_vec(k) + dt;
79     k = k + 1;
80 end

```

## Project #1\buckproc.m

```
1 % ID Number: 229,506
2 % ECE 31033 - Project #1
3 % buckproc.m
4
5 % The file buckproc.m first contains the circuit parameter values (i.e. L, C, fsw, time
6 % step, initial conditions etc.). Only the initial value of your circuit voltages and
7 % currents should be pre-established (i.e. Vload(1)=0). It then invokes buck. Finally,
8 % it performs your plotting and any post-processing calculations that are done
9 % using the simulated data (such as computing average values, efficiency, etc.).
10 %% Ideal - Given Values
11 V_in = 800;
12 V_load_avg = 400;
13 V_load_ripple = 10;
14 P_load_light = 50000;
15 P_load_heavy = 250000;
16 frequency = 10000;
17
18 ideal_boolean = 1; % = 0 if non ideal, = 1 if ideal; here, it is ON.
19
20 %% Ideal - Calculated Values
21 T_sw = 1 / frequency;
22 D = V_load_avg / V_in; % Duty Cycle
23
24 R_load_light = (V_load_avg^2) / P_load_light;
25 R_load_heavy = (V_load_avg^2) / P_load_heavy;
26
27 L_crit = (R_load_light * (1 - D)) / (2 * frequency);
28 L = L_crit * 1.1;
29
30 C = (V_load_avg / V_load_ripple) * (T_sw^2 * (1 - D)) / (8 * L);
31
32 I_load_light = V_load_avg / R_load_light;
33 I_load_heavy = V_load_avg / R_load_heavy;
34
35 i_L1_light = (V_load_avg / R_load_light) - (1 - D) * T_sw * V_load_avg / (2 * L);
36 i_L2_light = (V_load_avg / R_load_light) + (1 - D) * T_sw * V_load_avg / (2 * L);
37
38 i_L1_heavy = (V_load_avg / R_load_heavy) - (1 - D) * T_sw * V_load_avg / (2 * L);
39 i_L2_heavy = (V_load_avg / R_load_heavy) + (1 - D) * T_sw * V_load_avg / (2 * L);
40
41 %% Buck Initialization - Heavy Load
42 % Initializing Values
43 k = 1;
44 t = 0;
45 dt = 1e-7;
46
47 tend = 100 * T_sw;
48
49 % Zero Vectors (used in buck)
50 t_vec = [0];
51 switch_state = [0];
52
53 V_L_vec = [0];
```

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54 i_L_vec = [0];
55
56 V_C_vec = [0];
57 i_C_vec = [0];
58
59 V_load_vec = [0];
60 i_load_vec = [0];
61
62 V_switch1 = [0];
63 i_switch1 = [0];
64
65 V_switch2 = [0];
66 i_switch2 = [0];
67
68 %% Running Buck - Using R_load_heavy
69 R_load = R_load_heavy;
70 disp('Running buck for heavy load.');
```

buck

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72
73 %% Post-processing Calculations (computing avg values, efficiency, etc)
74 disp("-----")
75 disp("Heavy Averages:")
76
77 V_load_avg_func_H = aver(V_load_vec, T_sw, dt);
78 disp("  V_load Average: " + V_load_avg_func_H);
79
80 i_load_avg_func_H = aver(i_load_vec, T_sw, dt);
81 disp("  i_load Average: " + i_load_avg_func_H);
82
83 V_L_func_H = aver(V_L_vec, T_sw, dt);
84 disp("  V_L Average: " + V_L_func_H);
85
86 i_L_func_H = aver(i_L_vec, T_sw, dt);
87 disp("  i_L Average: " + i_L_func_H);
88
89 V_C_func_H = aver(V_C_vec, T_sw, dt);
90 disp("  V_C Average: " + V_C_func_H);
91
92 i_C_func_H = aver(i_C_vec, T_sw, dt);
93 disp("  i_C Average: " + i_C_func_H);
94
95 V_sw1_func_H = aver(V_switch1, T_sw, dt);
96 disp("  V_sw1 Average: " + V_sw1_func_H);
97
98 i_sw1_func_H = aver(i_switch1, T_sw, dt);
99 disp("  i_sw1 Average: " + i_sw1_func_H);
100
101 V_sw2_func_H = aver(V_switch2, T_sw, dt);
102 disp("  V_sw2 Average: " + V_sw2_func_H);
103
104 i_sw2_func_H = aver(i_switch2, T_sw, dt);
105 disp("  i_sw2 Average: " + i_sw2_func_H);
106
107 P_out_H = (V_load_avg_func_H^2) / R_load;
108 P_in_H = V_in * i_sw1_func_H;
109 eff_H = P_out_H / P_in_H;
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110
111 disp("Efficiency for Light Load: " + (eff_H * 100) + "%.");
112 disp("-----")
113
114 %% Plotting - Heavy Load - Transient
115 % Plots for the transient to steady state
116 figure;
117 sgtitle("Heavy Load: Voltage and Current Plots for All Components at Transient State");
118 % Plots for the Load
119 subplot(5,2,1);
120 plot(t_vec, V_load_vec);
121 title('Load Voltage vs Time');
122 xlabel('Time (ms)');
123 ylabel('Voltage (V)');
124
125 subplot(5,2,2);
126 plot(t_vec, i_load_vec);
127 title('Load Current vs Time');
128 xlabel('Time (ms)');
129 ylabel('Current (A)');
130
131 % Plots for the Inductor
132 subplot(5,2,3);
133 plot(t_vec, V_L_vec);
134 title('Inductor Voltage vs Time');
135 xlabel('Time (ms)');
136 ylabel('Voltage (V)');
137
138 subplot(5,2,4);
139 plot(t_vec, i_L_vec);
140 title('Inductor Current vs Time');
141 xlabel('Time (ms)');
142 ylabel('Current (A)');
143
144 % Plots for the Capacitor
145 subplot(5,2,5);
146 plot(t_vec, V_C_vec);
147 title('Capacitor Voltage vs Time');
148 xlabel('Time (ms)');
149 ylabel('Voltage (V)');
150
151 subplot(5,2,6);
152 plot(t_vec, i_C_vec);
153 title('Capacitor Current vs Time');
154 xlabel('Time (ms)');
155 ylabel('Current (A)');
156
157 % Plots for Switch 1
158 subplot(5,2,7);
159 plot(t_vec, V_switch1);
160 title('Transistor Switching Voltage vs Time');
161 xlabel('Time (ms)');
162 ylabel('Voltage (V)');
163
164 subplot(5,2,8);
165 plot(t_vec, i_switch1);

```

```

166 title('Transistor Switching Current vs Time');
167 xlabel('Time (ms)');
168 ylabel('Current (A)');
169
170 % Plots for Switch 2
171 subplot(5,2,9);
172 plot(t_vec, V_switch2);
173 title('Diode Switching Voltage vs Time');
174 xlabel('Time (ms)');
175 ylabel('Voltage (V)');
176
177 subplot(5,2,10);
178 plot(t_vec, i_switch2);
179 title('Diode Switching Current vs Time');
180 xlabel('Time (ms)');
181 ylabel('Current (A)');
182
183 %% Plotting - Heavy Load - Steady State
184 periods_to_plot = 2;
185
186 points_per_period = round(T_sw / dt); % Points per period
187 total_periods = floor(tend / T_sw); % Total number of periods in the simulation
188
189 start_index = max(1, (total_periods - periods_to_plot) * points_per_period + 1);
190 end_index = min(length(t_vec), total_periods * points_per_period);
191
192 range_to_plot = start_index:end_index;
193
194 %% Plot
195 figure;
196 sgtitle("Heavy Load: Voltage and Current Plots for All Components at Steady State");
197 % Plots for the Load
198 subplot(5,2,1);
199 plot(t_vec(range_to_plot), V_load_vec(range_to_plot));
200 title('Load Voltage vs Time');
201 xlabel('Time (ms)');
202 ylabel('Voltage (V)');
203
204 subplot(5,2,2);
205 plot(t_vec(range_to_plot), i_load_vec(range_to_plot));
206 title('Load Current vs Time');
207 xlabel('Time (ms)');
208 ylabel('Current (A)');
209
210 % Plots for the Inductor
211 subplot(5,2,3);
212 plot(t_vec(range_to_plot), V_L_vec(range_to_plot));
213 title('Inductor Voltage vs Time');
214 xlabel('Time (ms)');
215 ylabel('Voltage (V)');
216
217 subplot(5,2,4);
218 plot(t_vec(range_to_plot), i_L_vec(range_to_plot));
219 title('Inductor Current vs Time');
220 xlabel('Time (ms)');
221 ylabel('Current (A)');

```



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222
223 % Plots for the Capacitor
224 subplot(5,2,5);
225 plot(t_vec(range_to_plot), V_C_vec(range_to_plot));
226 title('Capacitor Voltage vs Time');
227 xlabel('Time (ms)');
228 ylabel('Voltage (V)');
229
230 subplot(5,2,6);
231 plot(t_vec(range_to_plot), i_C_vec(range_to_plot));
232 title('Capacitor Current vs Time');
233 xlabel('Time (ms)');
234 ylabel('Current (A)');
235
236 % Plots for Switch 1
237 subplot(5,2,7);
238 plot(t_vec(range_to_plot), V_switch1(range_to_plot));
239 title('Transistor Switching Voltage vs Time');
240 xlabel('Time (ms)');
241 ylabel('Voltage (V)');
242
243 subplot(5,2,8);
244 plot(t_vec(range_to_plot), i_switch1(range_to_plot));
245 title('Transistor Switching Current vs Time');
246 xlabel('Time (ms)');
247 ylabel('Current (A)');
248
249 % Plots for Switch 2
250 subplot(5,2,9);
251 plot(t_vec(range_to_plot), V_switch2(range_to_plot));
252 title('Diode Switching Voltage vs Time');
253 xlabel('Time (ms)');
254 ylabel('Voltage (V)');
255
256 subplot(5,2,10);
257 plot(t_vec(range_to_plot), i_switch2(range_to_plot));
258 title('Diode Switching Current vs Time');
259 xlabel('Time (ms)');
260 ylabel('Current (A)');
261
262 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
263 %% Buck Initialization - Light Load
264 % Initializing Values
265 k = 1;
266 t = 0;
267 dt = 1e-7;
268
269 tend = 250 * T_sw;
270
271 % Zero Vectors (used in buck)
272 t_vec = [0];
273 switch_state = [0];
274
275 V_L_vec = [0];
276 i_L_vec = [0];
277

```

```

278 V_C_vec = [0];
279 i_C_vec = [0];
280
281 V_load_vec = [0];
282 i_load_vec = [0];
283
284 V_switch1 = [0];
285 i_switch1 = [0];
286
287 V_switch2 = [0];
288 i_switch2 = [0];
289
290 %% Running Buck - Using R_load_light
291 R_load = R_load_light;
292 disp('Running buck for light load.');
```

buck

```

294
295 %% Post-processing Calculations (computing avg values, efficiency, etc)
296 disp("-----")
297 disp("Light Averages:")
298
299 V_load_avg_func_L = aver(V_load_vec, T_sw, dt);
300 disp("  V_load Average: " + V_load_avg_func_L);
301
302 i_load_avg_func_L = aver(i_load_vec, T_sw, dt);
303 disp("  i_load Average: " + i_load_avg_func_L);
304
305 V_L_func_L = aver(V_L_vec, T_sw, dt);
306 disp("  V_L Average: " + V_L_func_L);
307
308 i_L_func_L = aver(i_L_vec, T_sw, dt);
309 disp("  i_L Average: " + i_L_func_L);
310
311 V_C_func_L = aver(V_C_vec, T_sw, dt);
312 disp("  V_C Average: " + V_C_func_L);
313
314 i_C_func_L = aver(i_C_vec, T_sw, dt);
315 disp("  i_C Average: " + i_C_func_L);
316
317 V_sw1_func_L = aver(V_switch1, T_sw, dt);
318 disp("  V_sw1 Average: " + V_sw1_func_L);
319
320 i_sw1_func_L = aver(i_switch1, T_sw, dt);
321 disp("  i_sw1 Average: " + i_sw1_func_L);
322
323 V_sw2_func_L = aver(V_switch2, T_sw, dt);
324 disp("  V_sw2 Average: " + V_sw2_func_L);
325
326 i_sw2_func_L = aver(i_switch2, T_sw, dt);
327 disp("  i_sw2 Average: " + i_sw2_func_L);
328
329 P_out_L = (V_load_avg_func_L^2) / R_load;
330 P_in_L = V_in * i_sw1_func_L;
331 eff_L = P_out_L / P_in_L;
332
333 disp("Efficiency for Light Load: " + (eff_L * 100) + "%.");
```

```

334 disp("-----")
335 %% Plotting - Light Load - Transient
336 % Plots for the transient to steady state
337 figure;
338 sgtitle("Light Load: Voltage and Current Plots for All Components at Transient State");
339 % Plots for the Load
340 subplot(5,2,1);
341 plot(t_vec, V_load_vec);
342 title('Load Voltage vs Time');
343 xlabel('Time (ms)');
344 ylabel('Voltage (V)');
345
346 subplot(5,2,2);
347 plot(t_vec, i_load_vec);
348 title('Load Current vs Time');
349 xlabel('Time (ms)');
350 ylabel('Current (A)');
351
352 % Plots for the Inductor
353 subplot(5,2,3);
354 plot(t_vec, V_L_vec);
355 title('Inductor Voltage vs Time');
356 xlabel('Time (ms)');
357 ylabel('Voltage (V)');
358
359 subplot(5,2,4);
360 plot(t_vec, i_L_vec);
361 title('Inductor Current vs Time');
362 xlabel('Time (ms)');
363 ylabel('Current (A)');
364
365 % Plots for the Capacitor
366 subplot(5,2,5);
367 plot(t_vec, V_C_vec);
368 title('Capacitor Voltage vs Time');
369 xlabel('Time (ms)');
370 ylabel('Voltage (V)');
371
372 subplot(5,2,6);
373 plot(t_vec, i_C_vec);
374 title('Capacitor Current vs Time');
375 xlabel('Time (ms)');
376 ylabel('Current (A)');
377
378 % Plots for Switch 1
379 subplot(5,2,7);
380 plot(t_vec, V_switch1);
381 title('Transistor Switching Voltage vs Time');
382 xlabel('Time (ms)');
383 ylabel('Voltage (V)');
384
385 subplot(5,2,8);
386 plot(t_vec, i_switch1);
387 title('Transistor Switching Current vs Time');
388 xlabel('Time (ms)');
389 ylabel('Current (A)');

```

```

390
391 % Plots for Switch 2
392 subplot(5,2,9);
393 plot(t_vec, V_switch2);
394 title('Diode Switching Voltage vs Time');
395 xlabel('Time (ms)');
396 ylabel('Voltage (V)');
397
398 subplot(5,2,10);
399 plot(t_vec, i_switch2);
400 title('Diode Switching Current vs Time');
401 xlabel('Time (ms)');
402 ylabel('Current (A)');
403
404 %% Plotting - Light Load - Steady State
405 periods_to_plot = 2;
406
407 points_per_period = round(T_sw / dt); % Points per period
408 total_periods = floor(tend / T_sw); % Total number of periods in the simulation
409
410 start_index = max(1, (total_periods - periods_to_plot) * points_per_period + 1);
411 end_index = min(length(t_vec), total_periods * points_per_period);
412
413 range_to_plot = start_index:end_index;
414
415 %% Plot
416 figure;
417 sgtitle('Light Load: Voltage and Current Plots for All Components at Steady State');
418 % Plots for the Load
419 subplot(5,2,1);
420 plot(t_vec(range_to_plot), V_load_vec(range_to_plot));
421 title('Load Voltage vs Time');
422 xlabel('Time (ms)');
423 ylabel('Voltage (V)');
424
425 subplot(5,2,2);
426 plot(t_vec(range_to_plot), i_load_vec(range_to_plot));
427 title('Load Current vs Time');
428 xlabel('Time (ms)');
429 ylabel('Current (A)');
430
431 % Plots for the Inductor
432 subplot(5,2,3);
433 plot(t_vec(range_to_plot), V_L_vec(range_to_plot));
434 title('Inductor Voltage vs Time');
435 xlabel('Time (ms)');
436 ylabel('Voltage (V)');
437
438 subplot(5,2,4);
439 plot(t_vec(range_to_plot), i_L_vec(range_to_plot));
440 title('Inductor Current vs Time');
441 xlabel('Time (ms)');
442 ylabel('Current (A)');
443
444 % Plots for the Capacitor
445 subplot(5,2,5);

```

```

446 plot(t_vec(range_to_plot), V_C_vec(range_to_plot));
447 title('Capacitor Voltage vs Time');
448 xlabel('Time (ms)');
449 ylabel('Voltage (V)');
450
451 subplot(5,2,6);
452 plot(t_vec(range_to_plot), i_C_vec(range_to_plot));
453 title('Capacitor Current vs Time');
454 xlabel('Time (ms)');
455 ylabel('Current (A)');
456
457 % Plots for Switch 1
458 subplot(5,2,7);
459 plot(t_vec(range_to_plot), V_switch1(range_to_plot));
460 title('Transistor Switching Voltage vs Time');
461 xlabel('Time (ms)');
462 ylabel('Voltage (V)');
463
464 subplot(5,2,8);
465 plot(t_vec(range_to_plot), i_switch1(range_to_plot));
466 title('Transistor Switching Current vs Time');
467 xlabel('Time (ms)');
468 ylabel('Current (A)');
469
470 % Plots for Switch 2
471 subplot(5,2,9);
472 plot(t_vec(range_to_plot), V_switch2(range_to_plot));
473 title('Diode Switching Voltage vs Time');
474 xlabel('Time (ms)');
475 ylabel('Voltage (V)');
476
477 subplot(5,2,10);
478 plot(t_vec(range_to_plot), i_switch2(range_to_plot));
479 title('Diode Switching Current vs Time');
480 xlabel('Time (ms)');
481 ylabel('Current (A)');
482
483 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
484 %% Non Ideal - Given Values
485 V_T_on = 1;
486 V_D_on = 1;
487 R_T_on = 0.01;
488 R_D_on = 0.01;
489
490 ideal_boolean = 0; % = 0 if non ideal, = 1 if ideal; here, it is OFF.
491
492 %% Non Ideal - Calculated Values
493 R_load = R_load_heavy;
494 D_non_ideal = (V_D_on + V_load_avg + (R_D_on * V_load_avg / R_load));
495 D_non_ideal = D_non_ideal / (V_in - V_T_on + V_D_on + (R_D_on * V_load_avg / R_load) -
(R_T_on * V_load_avg / R_load));
496
497 i_L1_NI = (V_load_avg / R_load) - (((1 - D_non_ideal) * T_sw * V_load_avg) / (2 * L));
498 i_L2_NI = (V_load_avg / R_load) + (((1 - D_non_ideal) * T_sw * V_load_avg) / (2 * L));
499
500 %% Buck Initialization - Heavy Load

```

```

501 % Initializing Values
502 k = 1;
503 t = 0;
504 dt = 1e-7;
505
506 tend = 100 * T_sw;
507
508 % Zero Vectors (used in buck)
509 t_vec = [0];
510 switch_state = [0];
511
512 V_L_vec = [0];
513 i_L_vec = [0];
514
515 V_C_vec = [0];
516 i_C_vec = [0];
517
518 V_load_vec = [0];
519 i_load_vec = [0];
520
521 V_switch1 = [0];
522 i_switch1 = [0];
523
524 V_switch2 = [0];
525 i_switch2 = [0];
526
527 P_switch1 = [0]; % Power loss across the transistor; new for non-ideal calculations.
528 P_switch2 = [0]; % Power loss across the diode; new for non-ideal calculations.
529
530 %% Running Buck - Using R_load_heavy
531 R_load = R_load_heavy;
532 disp('Running buck for heavy load and non ideal conditions. ');
533 buck
534
535 %% Post-processing Calculations (computing avg values, efficiency, etc)
536 disp("-----")
537 disp("Non Ideal Averages:")
538
539 V_load_avg_func_NI = aver(V_load_vec, T_sw, dt);
540 disp(" V_load Average: " + V_load_avg_func_NI);
541
542 i_L_func_NI = aver(i_L_vec, T_sw, dt);
543 disp(" i_L Average: " + i_L_func_NI);
544
545 V_sw1_func_NI = aver(V_switch1, T_sw, dt);
546 disp(" V_sw1 Average: " + V_sw1_func_NI);
547
548 i_sw1_func_NI = aver(i_switch1, T_sw, dt);
549 disp(" i_sw1 Average: " + i_sw1_func_NI);
550
551 V_sw2_func_NI = aver(V_switch2, T_sw, dt);
552 disp(" V_sw2 Average: " + V_sw2_func_NI);
553
554 i_sw2_func_NI = aver(i_switch2, T_sw, dt);
555 disp(" i_sw2 Average: " + i_sw2_func_NI);
556

```

```

557 P_sw1_func_NI = aver(P_switch1, T_sw, dt);
558 disp(" P_sw1 Average: " + V_sw2_func_NI);
559
560 P_sw2_func_NI = aver(P_switch2, T_sw, dt);
561 disp(" P_sw2 Average: " + i_sw2_func_NI);
562
563 P_out_NI = (V_load_avg_func_NI^2) / R_load;
564 P_in_NI = V_in * i_sw1_func_NI;
565 eff_NI = P_out_NI / P_in_NI;
566
567 disp("Efficiency for Non-Ideal: " + (eff_NI * 100) + "%.");
568 disp("Transistor Power Loss: " + P_sw1_func_NI);
569 disp("Diode Power Loss: " + P_sw2_func_NI);
570 disp("-----")
571 %% Plotting - Non Ideal Heavy Load - Transient
572 % Plots for the transient to steady state
573 figure;
574 sgtitle("Non Ideal Heavy Load: Voltage and Current Plots for All Components at Transient
State");
575 % Plots for the Load
576 subplot(3,2,1);
577 plot(t_vec, V_load_vec);
578 title('Load Voltage vs Time');
579 xlabel('Time (ms)');
580 ylabel('Voltage (V)');
581
582 subplot(3,2,2);
583 plot(t_vec, i_L_vec);
584 title('Inductor Current vs Time');
585 xlabel('Time (ms)');
586 ylabel('Current (A)');
587
588 % Plots for Switch 1
589 subplot(3,2,3);
590 plot(t_vec, V_switch1);
591 title('Transistor Switching Voltage vs Time');
592 xlabel('Time (ms)');
593 ylabel('Voltage (V)');
594
595 subplot(3,2,4);
596 plot(t_vec, i_switch1);
597 title('Transistor Switching Current vs Time');
598 xlabel('Time (ms)');
599 ylabel('Current (A)');
600
601 % Plots for Switch 2
602 subplot(3,2,5);
603 plot(t_vec, V_switch2);
604 title('Diode Switching Voltage vs Time');
605 xlabel('Time (ms)');
606 ylabel('Voltage (V)');
607
608 subplot(3,2,6);
609 plot(t_vec, i_switch2);
610 title('Diode Switching Current vs Time');
611 xlabel('Time (ms)');

```

```

612 ylabel('Current (A)');
613
614 %% Plotting - Heavy Load - Steady State
615 periods_to_plot = 2;
616
617 points_per_period = round(T_sw / dt); % Points per period
618 total_periods = floor(tend / T_sw); % Total number of periods in the simulation
619
620 start_index = max(1, (total_periods - periods_to_plot) * points_per_period + 1);
621 end_index = min(length(t_vec), total_periods * points_per_period);
622
623 range_to_plot = start_index:end_index;
624
625 %% Plot
626 figure;
627 sgtitle("Non Ideal Heavy Load: Voltage and Current Plots for All Components at Steady State")
628 ;
629 % Plots for the Load
630 subplot(3,2,1);
631 plot(t_vec(range_to_plot), V_load_vec(range_to_plot));
632 title('Load Voltage vs Time');
633 xlabel('Time (ms)');
634 ylabel('Voltage (V)');
635
636 subplot(3,2,2);
637 plot(t_vec(range_to_plot), i_L_vec(range_to_plot));
638 title('Inductor Current vs Time');
639 xlabel('Time (ms)');
640 ylabel('Current (A)');
641
642 % Plots for Switch 1
643 subplot(3,2,3);
644 plot(t_vec(range_to_plot), V_switch1(range_to_plot));
645 title('Transistor Switching Voltage vs Time');
646 xlabel('Time (ms)');
647 ylabel('Voltage (V)');
648
649 subplot(3,2,4);
650 plot(t_vec(range_to_plot), i_switch1(range_to_plot));
651 title('Transistor Switching Current vs Time');
652 xlabel('Time (ms)');
653 ylabel('Current (A)');
654
655 % Plots for Switch 2
656 subplot(3,2,5);
657 plot(t_vec(range_to_plot), V_switch2(range_to_plot));
658 title('Diode Switching Voltage vs Time');
659 xlabel('Time (ms)');
660 ylabel('Voltage (V)');
661
662 subplot(3,2,6);
663 plot(t_vec(range_to_plot), i_switch2(range_to_plot));
664 title('Diode Switching Current vs Time');
665 xlabel('Time (ms)');
666 ylabel('Current (A)');

```