WEB ASSISTED DESIGN OF COMMUNICATION CIRCUITS AND SYSTEMS

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Abstract: Online calculators, generators, wizards and free design tools increased considerably the accessibility of communication circuits and systems design. The paper presents a study on the online design tools and defines design tasks that can be solved with their assistance. The concept of Local resources, assisted by Web assistants in a Web portal, is considered. The Web assistants in the portal integrate Sets of connexions and e-Content. The paper gives examples combining online tools with locally installed Computer-aided design (CAD) tools for more effective communication circuits and systems design.

1 INTRODUCTION

Nowadays we are witnessing a boom of specialized web resources, online platforms, portals, programs, calculators. Smaller or bigger centers make research, characterization, categorization and development of sets of connections to these web resources. One of the biggest centers for connections with specialized online resources is the MARTINDALE'S Calculators Online Center (MARTINDALES) where connections are built forward 24385 online calculators, 4145 e-learning materials and lecture courses and 1000 films, video and animation products and simulations, created by more than 8620 authors from all over the world. The web connections in the Center are categorized by areas, covering a very wide specter, from agriculture and archeology passing through mathematics and engineering and ending by physics and chemistry.

Smaller specialized portals in the area of communications exist, as for example, the portals of the SPICE community (YOUSPICE, e-CircuitCenter, etc.), the portals for audio design, which have built sets of tens to hundreds of connections to useful resources in the Web. Besides the disconnected online resources, online platforms for solving complex research and design tasks in communications became accessible during the last years. The Free online platform for switch-mode power supply (SMPS) design, on web address www.PowerEsim.com and the SCA-Based Open Source Software Defined Radio on web address http://ossie.wireless.vt.edu/ are such examples. Both are developed as result of serious scientific projects. PowerEsim is the result of a research project in Hong Kong, and SCA-Based Open Source Software Defined Radio is the result from a project of the National Research Foundation in USA. All specialized online platforms and portals can be used in education, but this is neither their main application, nor the unique one. They make accessible an environment for solving real tasks from system design in communications with elements of business analysis and decisions. Some of these platforms integrate local resources with online resources for solving design and test tasks. The platforms as WeBench Designer of Texas Instruments: for designing SMPS, LED, FPGA, Sensors, which make available considerable free resources, are between the most popular in this category. We have experienced applying online resources mainly in e-education and most universities have e-Learning Centers or Distance Learning Centers. In the present work the accent is on the Useful resource on the web and the development of Sets of connections in order to solve Computer-aided design (CAD) tasks in the area as communications. Thus acceleration of scientific research can be achieved.

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2 CONCEPT OF PORTAL WITH WEB ASSISTANTS TO LOCAL RESOURCES FOR CAD OF COMMUNICATION CIRCUITS AND SYSTEMS

A Multitool environment for Computer-Aided Design in Communications was described in (Marinova, 2010). The goal was to combine multiple tools in order to design a communication system. The set, of locally installed CAD tools in the environment, is composed from the following programs:

- MATLAB,
- ORCAD/Capture, ORCAD/Layout,
- PSpice A/D and Advanced analysis,
- WARP 6.2,
- ISE WEBPACK,
- QUARTUS II,
- MMICAD,
- FilterCAD,
- PAC Designer,
- MICROWIND.

The integration of these tools for solving different tasks is described in details in (Marinova, 2010). At a next step it becomes interesting to assist these Local resources by a Set of Useful online resources. This is realised through definition of a Set of CAD tasks suitable for the Local resources. Then a Portal is developed with Web assistants in order to provide knowledge from the web helping the task solution. The Web assistants are composed by a Set of connections to the Useful web resources and e-Content. The Useful net resources are determined after a serious research in the web and selection of online tools suitable for the Set of CAD task. Additional tests and verifications of the online tools are performed before admitting them as a Useful resource. A characterization is made for their application area. The Concept of the Web assistants combined to Local resources, for CAD of communication circuits and systems is presented on Figure 1. The Portal with Web assistants for CAD of communication circuits and systems is presented on Figure 2.

A set of CAD tasks is defined:

- Antenna design;
- LED array, controller and driver design;
- Switch-mode power supplies (SMPS) design;
- Design with PSpice;
- PCB trace estimation;
- PCB design price estimation.

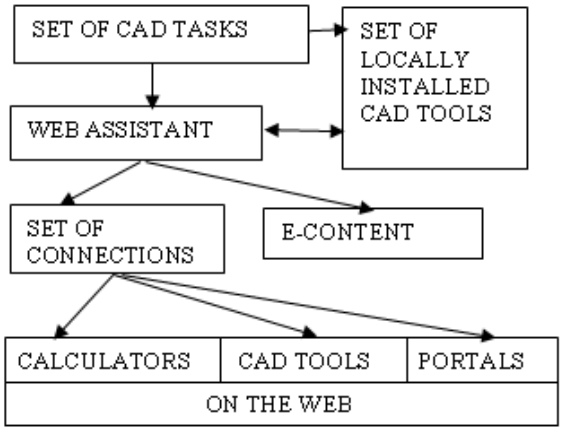


Figure 1.

Figure 2.

3 SETS OF CONNECTIONS IN THE WEB ASSISTANTS

The Set of connections for each Web assistant is built after a serious research in the web for online calculators, tools and materials, related to the corresponding Set of CAD tasks. Each online tool is tested and if the test result is satisfactory the web address is added to the Set of connections. Each online tool is accompanied by short characteristics, describing its specific functions. Six Sets of

connections are built in order to assist solving the Set of CAD tasks described above:

Set of connections for Antenna design: 10 online calculators are considered for the design of 7 of the most popular types of antennas: LPDA, Yagi, Moxon, Helix, Microstrip Patch, Delta loop and Magnetic loop. The Set is presented in Table 1.

Set of connections for LED array, driver and controller design: 5 online calculators and one free downloadable program for LED array design, Current limiting resistor calculation, LED driver design and LED controller programming are selected and presented in Table 2.

Set of connections for SMPS design: The free online platform for SMPS design PowerEsim, as well as WEBENCH POWER DESIGNER (TI) and a portal for SMPS projects simulated with PSpice are selected and presented in Table 3. The PowerEsim platform was tested. Verification with PSpice was performed for the design of a Full bridge DC-DC converter and the results from the verification are presented in (Marinova, July 2012). The content of the portal SMPS was studied in details and an application limitation coming from the paid PSpice projects of SMPS was observed.

Set of connections for Design with Spice – Three portals – eCircuitCenter, YOUSPICE and SMPS are selected and considered and the set of connections is presented in Table 4. The free Circuits collections were tested with a local PSpice A/D tool and several remarks and corrections were reported for some of the projects in these portals. The specific advantage of the portal YOUSPICE is the mechanism for SPICE project exchange. New point in the portal eCircuitCenter is the online EXCEL based design calculations for the design of certain circuits – audio amplifiers for example. The PSpice projects of the portal SMPS are entirely paid and even the electrical circuit of the SMPS is not fully visible without registration.

Set of connections for PCB trace estimation – 6 online calculators are selected and a free downloadable tool Saturn and their main characteristics are presented in Table 5.

Set of connections for PCB design price estimation – an online calculator and 2 tabular online tools are selected and presented in Table 6.

The research covers until now 32 resources from the Web which are selected, studied and added to the Sets of connections to the Web assistants in the Portal for computer-aided design of communication circuits and systems. The research continues by adding new Sets of connections with:

- Online calculators for resistors and capacitors;
- Online matching network tools – Smith Chart diagram tools;
- Online analogue/digital/crystal filters design tools;
- Online 555 timer calculators;
- Online design tools for loudspeakers and microphones (mono and stereo);
- Online SCA based open source software defined radio - OSSIE.

4 ILLUSTRATIVE EXAMPLES OF WEB ASSISTED COMPUTER-AIDED DESIGN

In (Marinova, June 2012) there are some examples given for web assisted computer aided design. Two additional examples, design with WENENCH LED DESIGNER and design with WARP 6.2. and LED current limiting resistor calculator, are given further.

4.1 Design of LED array with 5x7 orange LEDs and a driver in WEBENCH LED DESIGNER

Orange LEDs 35 (5x7), with forward voltage 2.9 V and forward current of 0.35 mA, are chosen. The power supply is 12 V. The LEDs chosen for the design are Philips LXML Ph01.

WEBENCH LED DESIGNER proposes a list of drivers suitable for such LEDs. Besides the driver IC and the datasheet, an electrical circuit is proposed for each driver. The drivers with the highest efficiency are selected. Then they are compared for their dimensions and price. The driver chosen for the design is LM3424MH and the electrical circuit of the design is presented on Figure 3.

4.2 Design of LED array 16x4 controlled by shift registers and pseudo-random vector generator

The electrical circuit in ORCAD/Capture of the LED array 16x4 controlled by shift registers and pseudo-random vector generator (PRVG) is presented on Figure 4. The 4 shift registers and the PRVG are described in VHDL and simulated on CYPRESS CPLD in WARP 6.2 (www.cypress.com). The limiting current resistors R1-R64 from Fig. 3 are calculated in the online calculator Ledz. From Table 2.

Table 1: Set of connections for Antenna design

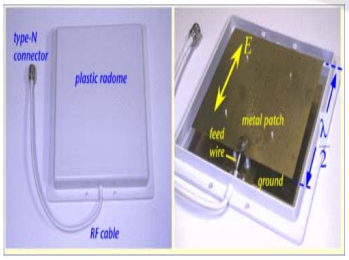
Antenna	Picture	Calculator	Web address in the Set of connections
Log Periodic antenna LPDA		Changpuak	http://www.changpuak.ch/electronics/lpda.php
Yagi antenna		Radiohobby	http://radiohobby.hit.bg/antcalc.htm
		Va3css	http://www.va3css.ca/calculators.html
Moxon antenna		Vp9kf	http://w4.vp9kf.com/moxon_design.htm
Helix antenna		Jcoppens	http://jcoppens.com/ant/helix/calc.en.php
		Daycounter	http://www.daycounter.com/Calculators/Helical-Antenna-Design-Calculator.phtml
Microstrip patch antenna		Emtalk	http://www.emtalk.com/mpacalc.php
Delta loop antenna		DxZone	http://www.dxzone.com/catalog/Antennas/Antenna_Calculators/
Magnetic loop antenna		66pacific	http://www.66pacific.com/calculators/small_tx_loop_calc.aspx
		Am-dx	http://www.am-dx.com/loop_calc.htm

Table 2: Set of connections for LED array, controller and driver design

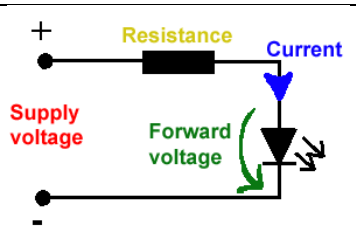
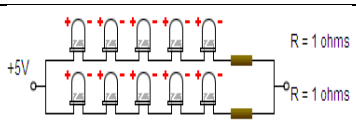
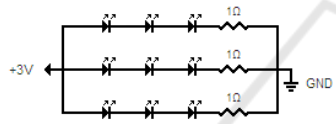
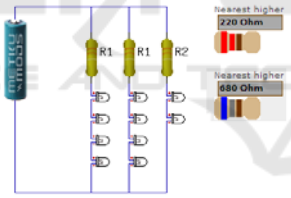
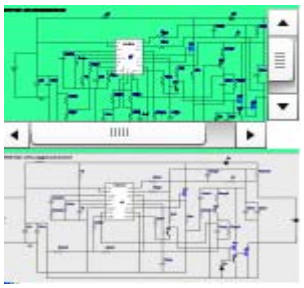
LED calculator	Illustration	Functions	Web address in the Set of connections
Ledz		Current limiting resistor calculation for one or several LEDs connected serially or in parallel	http://ledz.com/?p=zz.led.resistor.calculator
Ledlinear		LED serial/parallel array design	http://led.linear1.org/
LedCalculator		LED serial/parallel array design	http://ledcalculator.net/
LedCalc		LED serial/parallel array design	http://ledcalc.com/
WEBENCH LED Designer		LED driver circuit design and efficiency calculation	http://www.ti.com/ww/en/analog/webench/led.shtml
MAX6952		Programming LED controllers	http://www.scienceprog.com/drive-dot-led-matrix-display-using-lpt-port-and-driver-ic/

Table 3: Set of connections for SMPS design

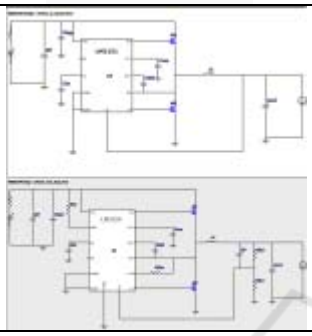
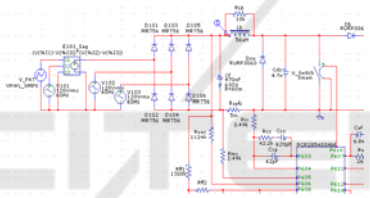
CAD tool or Portal	Illustration	Characteristics	Web address in the Set of connections
PowerEsim		Online platform for SMPS design – free Transformer calculator Simulation tool	www.poweresim.com
WEBENCH POWER DESIGNER		Multiple circuit synthesis and optimization	http://webench.ti.com/webench5/power
SMPS		PSpice projects for SMPS – all paid	www.smps.com

Table 4: Set of connections for Design with PSpice

Portal	Characteristics	CAD tools	Circuit collection	Free or paid	Web address in the Set of connections
eCircuitCenter	Project design with EXCEL and simulation with PSpice	PSpice EXCEL	115 projects in 16 categories	Free	www.ecircuitcenter.com
YOUSPICE	Project exchange	ORCAD PSpice; Micro-Cap; LTspice; TINA; EDWinXP; Proteus; NI Multisim; Altium Designer; SPICE OPUS.	392 projects in 14 categories	Free and Paid 72 free projects	www.youspice.com
SMPS	SMPS projects	PSpice	SMPS projects	Paid	www.smps.com

Table 5: Set of connections for PCB trace estimation

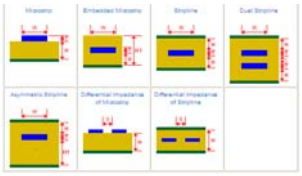
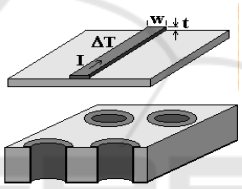
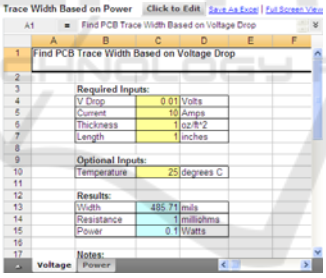
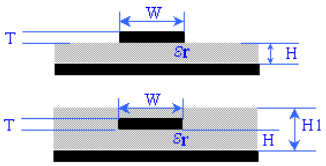
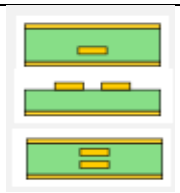
Calculator	Characteristic	Illustration	Web address in the Set of connections
Saturn PCB Design toolkit v.5.6.	Free downloadable software for Via, Conductor, Signal properties calculation, PDN impedance, Thermal, Fusing current etc.		http://www.saturnpcb.com/pcb_toolkit.htm
TECHNIK	Impedance, Inductance, capacity calculation for 7 different geometries		http://www.technick.net/public/code/cp_dpage.php?aiocp_dp=util_pcb_imp_calculator
Selektronik	Impedance, crosstalk, current carrying capacity, thermo-via calculation		http://www.skottanselektronik.com/
Wordpress	Trace Width calculation based on power, using EXCEL		http://circuitcalculator.com/wordpress/2006/04/20/find-pcb-trace-width-based-on-power/
EMCLAB	Trace impedance calculation for 4 different geometries		http://emclab.mst.edu/pcbtlc2/
EEWEB	Trace impedance calculation for 9 different geometries of microstrip, striplines and coupled and/or embedded striplines		http://www.eeweb.com/toolbox/microstrip-impedance/

Table 5: Set of connections for PCB trace estimation (continue)

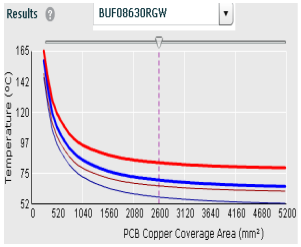
TI PCB THERMAL CALCULATOR	Device junction temperature estimation More than 200 TI ICs supported		http://www.ti.com/adc/docs/midlevel.tsp ?contentId=76735

Table 6: Set of connections for PCB design price estimation

PCB design price calculator	**Characteristics**	**Web address in the Set of connections**
MIKRON 20	Calculates the price of PCB production and assembly	http://www.micron20.com/bg/orders/calculator-production/ http://www.micron20.com/bg/orders/calculator-assembly/
SKA	Prices for PCB production are presented in tables as well as percentage for additional services	http://www.cka-bg.com/index.php?page=tseni-pechatni-platki&hl=bg_BG
MLAD KONSTRUKTOR	Prices for PCB production are presented in tables	http://constructor.bg/shop/pcb_order_2.php

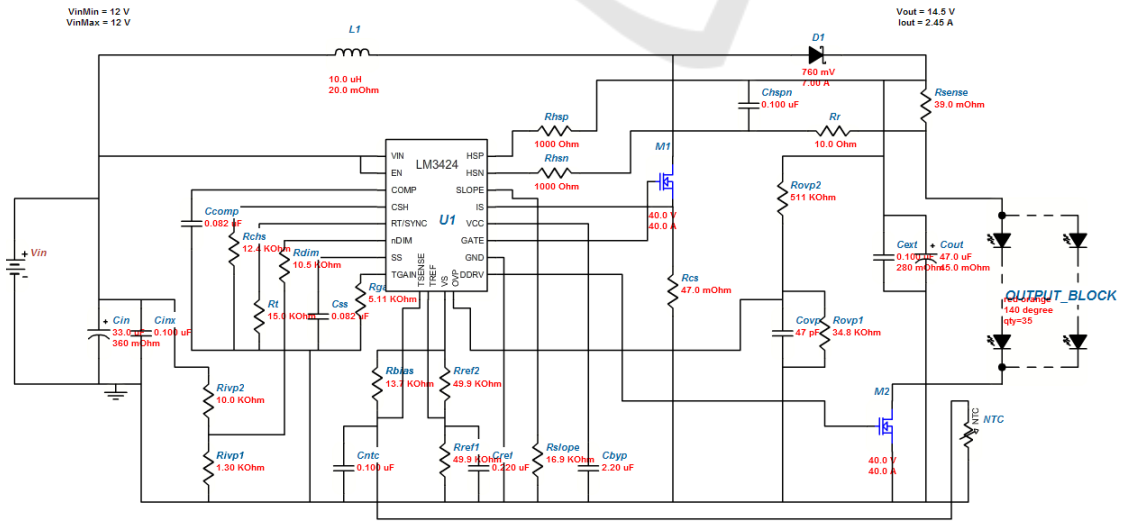


Figure 3.

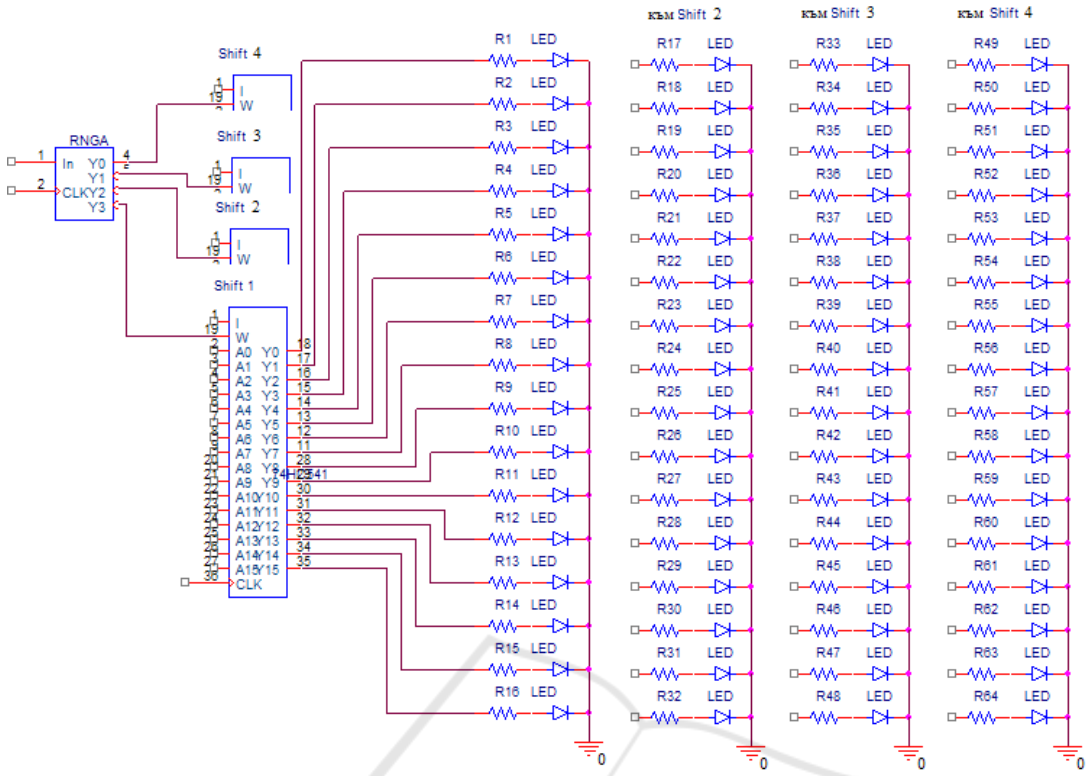


Figure 4.

The VHDL description of the 4 bit pseudo random vector generator is:

```
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;
entity rng is
     generic ( wd : integer := 32 );
     port (clk : in std_logic;
              random_num : out std_logic;
              random_4bit: out
std_logic_vector (3 downto 0));
end rng;

architecture Behavioral of rng is
signal rand_temp : std_logic_vector(wd-1
downto 0);
signal temp : std_logic;
  begin
       process(clk)
            begin
         if(clk'event and clk='1') then
         temp <= not(rand_temp(wd-1) xor
         rand_temp(wd-2));
         rand_temp(wd-1 downto 1) <=
         rand_temp(wd-2 downto 0);
         rand_temp(0) <= temp;
         end if;
       end process;
random_num <= rand_temp(wd-1);
random_4bit(3)<= rand_temp(wd-1);
random_4bit(2)<= rand_temp(wd-2);
random_4bit(1)<= rand_temp(wd-3);
random_4bit(0)<= rand_temp(wd-4);
end Behavioral;
```

The PRVG described in VHDL is simulated in WARP 6.2 and the waveforms obtained are presented on Figure 5. The input is the clock signal and the 4-bit vectors generated are obtained at random_4bit. The random numbers are presented in decimal form.

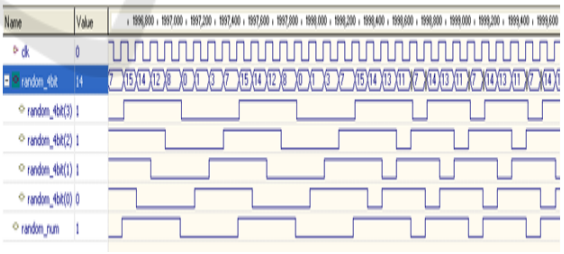


Figure 5.

The functionality of the circuit from Figure 4 is presented on Figure 6, where red circles indicate lighting LEDs.

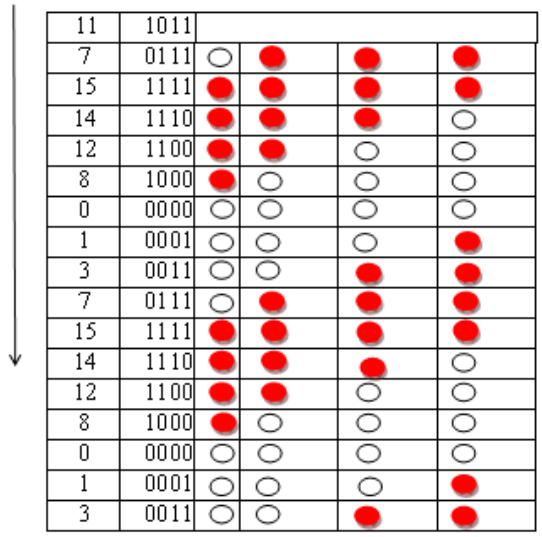


Figure 6.

This design is a good illustration of the advantages of combined utilization of Local resources as WARP 6.2 and online calculator as Ledz.

5 CONCLUSIONS

The paper illustrates the concept of a Portal with Web assistants, developed to help the solutions of Tasks for computer aided design in communications.

The Web assistants are composed by Sets of connections with Useful web resources and e-Content. The research work concerning 6 tasks for CAD is presented in the paper and the Sets of connections with online calculators and other web resources of the Web assistant in the Portal are considered in details. Two examples of LED design are described in order to illustrate the approach. Further work is planned in order to enlarge the Portal with new Web assistants and new Sets of connections for solving new Tasks for CAD in communications.

REFERENCES

Marinova, G., June 2012, Multitool online assisted design of communication circuits and systems, *ICEST'2012*, Veliko Tarnovo

Marinova, G., 2010, Multidisciplinary approach for teaching Computer-Aided Design in communications using multiple software tools, *Advanced Aspects of Theoretical Electrical Engineering Sozopol '2010,* Sozopol, Bulgaria, Plenary lectures, pp. 34 -42

Marinova, G., July 2012, PSpice as a Verification Tool for Switch Mode Power Supply Design with PowerEsim, *NDES'2012*, Wofenbuttel, Germany, pp.140-143, ISBN:978-3-8007-3444-3

MARTINDALE'S Calculators Online Center http://www.martindalecenter.com/Calculators.html