University of Genova, Italy. DIME Department of Mechanical, Energy, Management and Transportation Engineering

MSc Course in Energy Engineering (En2), www.en2.unige.it

En2 Admission Test EXAMPLE, Version april 2016

Tick the proper column according to the selected response.
Each correct answer gives 2 points, each incorrect answer -1. No answer is equal to 0 points.

The Test is passed provided that a minimum of 36 points is attained

CANDIDATE FULL NAME AND SIGNATURE

	A	B	C
1) The gradient of the function $f(x,y) = y\frac{e^{-x}}{x}$ is: **A** $\left(ye^{-x}, \frac{e^{-x}}{x}\right)$ **B** $\frac{e^{-x}}{x}\left(-y\frac{x+1}{x}, 1\right)$ **C** $-y\frac{(x+1)e^{-x}}{x^2}$			
2) The gradient at a point P of a differentiable function f **A** gives the direction in which f has the maximal rate of increase **B** if it is zero, it means that f has a maximum or a minimum in P **C** is a scalar function			
3) Let $\|x\| = \sqrt{x^2+y^2+z^2}$, the divergence of the vector field $\left(x/\|x\|^3, y/\|x\|^3, z/\|x\|^3\right)$ is **A** 0 **B** $(0,0,0)$ **C** $3/\|x\|^3$			
4) Which of the following subset of R^3 is a vector space (or linear space)? **A** a sphere centered at the origin, with radius 1 **B** each plane through the origin **C** each plane			
5) What is the correct definition of the Reynolds number? **A** $\mathrm{Re} = \frac{wL}{\mu}$ **B** $\mathrm{Re} = \frac{wL\rho}{v}$ **C** $\mathrm{Re} = \frac{wL\rho}{\mu}$			

6) What is a true formulation of the Fourier law?

A $\dot{Q}'' = -k\frac{dT}{dx}$ [W/m^2]

B $\dot{Q} = kA\frac{dT}{dx}$ [W]

C $\dot{Q} = -hA\frac{dT}{dx}$ [W]

7) What is a true formulation of the Newton law?

A $\dot{Q}'' = hA(T_s - T_\infty)$ [W/m^2]

B $\dot{Q}'' = h(T_s^4 - T_\infty^4)$ [W/m^2]

C $\dot{Q}'' = h(T_s - T_\infty)$ [W/m^2]

8) What are the units of the spectral emissive power $E_{b\lambda}(\lambda, T)$?

A $\left[\frac{W}{m\,\mu m}\right]$

B $\left[\frac{W}{m^2\,\mu m}\right]$

C $\left[\frac{W}{m\,K}\right]$

9) In a pipe with internal diameter of 2 cm flows some water at room temperature and an average velocity of 1 m/s. What is its mass flow rate?

A 0.314 kg/s **B** 0.314 l/s **C** 3.14 l/min

10) Consider water at room temperature flowing at the average velocity of 5 cm/s in an horizontal pipe with constant internal diameter of 2 cm. The water cinematic viscosity is 10^{-6} m^2/s. Calculate the pressure drops for each meter of tube.

A 4 bar/m **B** 4 Pa/m **C** 40 Pa/m

11) What are the units of the thermal conductivity *k* and of the convective coefficient *h* in SI?

A $\left[\frac{W}{mK}\right]$ $\left[\frac{W}{m^2K}\right]$

B $\left[\frac{W}{m^2K}\right]$ $\left[\frac{W}{mK}\right]$

C $\left[\frac{W}{mK}\right]$ $\left[\frac{W}{K}\right]$

12) What is a true formulation of the thermal resistance in cylindrical coordinates?

A $R_{cond} = \frac{1}{2\pi kA} \ln \frac{r_2}{r_1}$ [K/W]

B $R_{cond} = \frac{1}{2\pi kL} \ln \frac{r_2}{r_1}$ [m^{2}K/W]

C $R_{cond} = \frac{1}{2\pi kL} \ln \frac{r_2}{r_1}$ [K/W]

13) Which is the correct equation for perfect gases (p is pressure, v is specific volume, R is the gas constant - specific for each gas, and T is absolute temperature)?

A $p \cdot v = const.$ **B** $\frac{p}{v} = R \cdot T$ **C** $p \cdot v = R \cdot T$

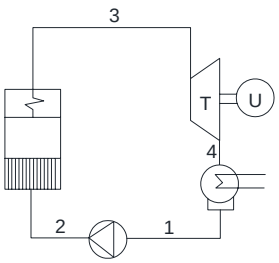
14) Which names correspond to heat exchangers or heat exchanger types?

A Shell and Tubes **B** expansion valve **C** Countercurrent

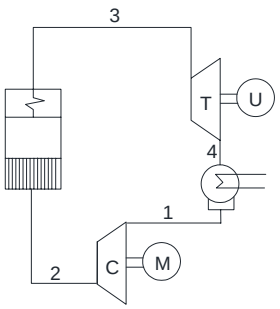
15) Which is the efficiency value for a Carnot cycle operating at T_{max}=1200°C and T_{min}=50°C?

A 0.73 **B** 0.96 **C** 0.78

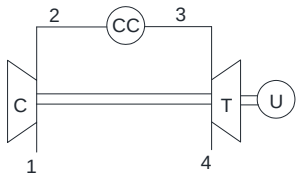
16) Which is the right basic plant scheme for a steam power plant?



A

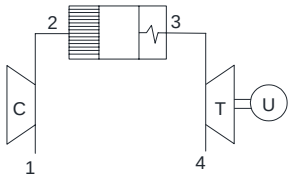


B

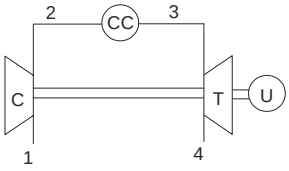


C

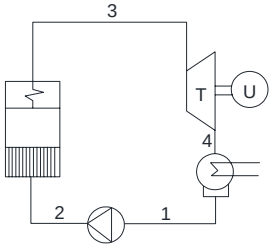
17) Which is the right basic plant scheme for a turbogas plant (open cycle)?



A



B



C

18) Considering the expander of a turbogas working under the conditions in the brackets (mass flow rate: 100 kg/s, inlet enthalpy: 1500 kJ/kg, outlet enthalpy: 600 kJ/kg), which power value is it producing?

A 90 MW **B** 90 kW **C** 27.3 MW

19) Which types of simple energy systems are present in a combined plant?

A Internal combustion engine + Steam power plant
B Turbogas + Steam power plant
C Turbogas + Internal combustion engine

20) Which of these phases are producing positive work (work is considered positive when it is transferred from the thermodynamic system to external components) in an internal combustion engine?

A Expansion **B** Compression **C** Exhaust discharge

21) Which is the expression of the efficiency for the ideal Otto cycle (β is the pressure ratio, ρ is the volume ratio and k is the ratio between constant pressure and constant volume specific heats)?

A $\eta = 1 - \beta^{k-1}$ **B** $\eta = 1 - \rho^{k-1}$ **C** $\eta = 1 - \frac{1}{\rho^{k-1}}$

22) Which are the names of the main hydraulic turbines?

A Curtis, Francis, Ljungström
B Pelton, Francis, Kaplan
C Pelton, Francis, Ljungström

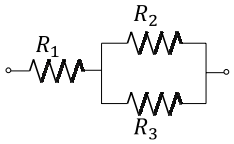
23) A constant electric current i flows through a resistor of resistance R. The voltage v across the resistor and the power p that the resistor converts to heat are:

A $\begin{cases} v = Ri \\ p = Ri^2 \end{cases}$ **B** $\begin{cases} v = \frac{i}{R} \\ p = Ri \end{cases}$ **C** $\begin{cases} v = Ri^2 \\ p = -\frac{i^2}{R} \end{cases}$

24) If the electric current that flows through an inductor of inductance L increases from 0 to a steady value i, then the energy U stored in the inductor (i.e., the energy associated with the magnetic field established in the inductor) is:

A $U = Li$ **B** $U = \frac{1}{2}Li^2$ **C** $U = 0$

25) The equivalent resistance of the network of resistors in the figure is:



A $R_1 R_2 R_3$ B $\frac{R_1(R_2 + R_3)}{R_1 + R_2 + R_3}$ C $R_1 + \frac{R_2 R_3}{R_2 + R_3}$

26) A voltage v is applied across a resistor of resistance R. The power p that the resistor converts to heat is:

A $p = Rv^2$ **B** $p = \frac{v^2}{R}$ **C** $p = \frac{v}{R}$

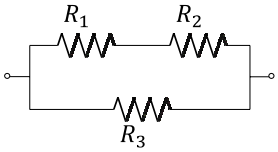
27) Which of the following is a correct statement of Kirchhoff's current law?

A At any junction in any electric circuit, the sum of the absolute values of all electric currents, either entering or exiting the node, is zero.
B At any junction in any electric circuit, the algebraic sum of all electric currents, either entering or exiting the node, is zero.
C The voltage across a resistor is proportional to the current flowing through the resistor itself.

28) An initially fully discharged capacitor with capacitance C is charged up to reaching a steady voltage v. The energy U stored in the capacitor (i.e., the energy associated with the electrostatic field established in the capacitor) is:

A $U = \frac{1}{2}Cv^2$
B $U = Cv$
C U cannot be computed because the charges on the two conductors of the capacitor are unknown.

29) The equivalent resistance of the network of resistors in the figure is:



A $R_1 + R_2 + R_3$ **B** $\frac{(R_1 + R_2)R_3}{R_1 + R_2 + R_3}$ **C** $R_1R_2R_3$

30) The voltage across a capacitor with capacitance C changes from v to $v + \Delta v$ in a given time range. The resulting variation in the energy U stored in the capacitor is:

A $\Delta U = \frac{1}{2}C(v + \Delta v)^2 - \frac{1}{2}Cv^2$ **B** $\Delta U = 0$
C $\Delta U = \frac{1}{2}C(\Delta v)^2$