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MASTER'S DEGREE PROGRAMME IN ADVANCED AUTOMOTIVE ENGINEERING

Aecf go le'[gct 2017/2018

Multiple Choice Questions

1. **A turbomachinery is a:**
   A) Rotating machinery
   B) Turbine
   C) Compressor
   D) Positive displacement machine
   E) Dishwasher

2. **Which group is composed of operating machinery only?**
   A) pump, turbine, fan
   B) pump, compressor, fan
   C) pump, internal combustion engine, compressor
   D) fan, internal combustion engine, compressor
   E) fan, heat exchanger, compressor

3. **The main objective of surpercharging is:**
   A) increased efficiency
   B) environmental benefit
   C) increased power output
   D) cooling of the piston
   E) heating of the exhaust duct

4. **The thermodynamic parameter on which the supercharging operates is:**
   A) the air specific heat
   B) the air viscosity
   C) the fuel density
   D) the stoichiometric Air-to-Fuel ratio
   E) the air density

5. **The volute or scroll of a turbomachine is a:**
   A) bearing of the main shaft
   B) spiral-shaped housing
   C) positive displacement machine
   D) intercooling heat exchanger
   E) inlet guide vane

6. **The typical flame structure in spark-ignited internal combustion engines operated at full load and medium engine speed (eg. 3000rpm) is:**
   A) a thin "laminar" sheet, corrugated and distorted by large-scale and small-scale local turbulent eddies
   B) a thick "laminar" sheet, corrugated and distorted by local small-scale turbulent eddies and thickened by local large-scale turbulent eddies
   C) a thick "turbulent" sheet dominated by local turbulent diffusion
   D) a spherical expanding sheet whose propagation speed is independent of local turbulence
   E) a spherical volume whose inner structure is similar to a well-stirred reactor

7. **Knock tendency in spark-ignited internal combustion engines:**
   A) Decreases for increasing fuel RON, engine compression ratio, engine bore, engine turbulence intensity
   B) Decreases for decreasing fuel RON and engine compression ratio and for increasing engine bore and engine turbulence intensity
   C) Increases for increasing fuel RON, engine compression ratio, engine bore, engine turbulence intensity
   D) Increases for increasing fuel RON and engine compression ratio and decreasing engine bore and engine turbulence intensity
   E) Increases for decreasing fuel RON and engine turbulence intensity and for increasing engine bore and compression ratio

8. **Please choose the correct temporal sequences of phenomena experienced by high-pressure fuel sprays when directly injected in a typical engine combustion chamber:**
   A) Droplet-to-droplet break-up, atomization, evaporation, mixing, deposition, wall-impingement
   B) Atomization, droplet-to-droplet break-up, evaporation, mixing, wall-impingement, deposition
   C) Atomization, droplet-to-droplet break-up, evaporation, mixing, reaction
   D) Atomization, droplet-to-droplet break-up, evaporation, wall impingement, deposition
   E) Atomization, droplet-to-droplet break-up, wall impingement, deposition

9. **Please choose the correct design solutions to increase in-cylinder turbulence levels at Firing Top Dead Center:**
   A) design large-section straight intake ports with a reduced inclination relative to the valve axis to increase tumble formation during the intake stroke, especially in spark-ignited engines
   B) design small-section intake ports with a relevant inclination relative to the valve axis to increase tumble formation during the compression stroke, both in spark-ignited and compression-ignited engines
   C) design small-section intake ports with a relevant inclination relative to the valve axis to increase tumble formation during the intake stroke in spark-ignited engines
   D) increase the squish area and decrease the squish height in both spark-ignited and compression-ignited engines
   E) increase the squish area and decrease the squish height in spark-ignited while decrease the squish area and increase the squish height and compression-ignited engines

10. **Consider a simple ideal Rankine cycle with fixed boiler and condenser pressures. If the steam is superheated to a higher temperature:**
    A) the turbine work output will decrease
    B) the amount of heat rejected will decrease
    C) the cycle efficiency will decrease
    D) the moisture content at turbine exit will decrease
    E) the amount of heat input will decrease

11. **Consider a simple ideal Rankine cycle with fixed boiler and condenser pressures. If the cycle is modified with reheating:**
    A) the turbine work output will decrease
    B) the amount of heat rejected will decrease
    C) the pump work input will decrease
    D) the moisture content at turbine exit will decrease
    E) the amount of heat input will decrease

12. **Heat conduction phenomena:**
    A) occur in fluids only
    B) involve heat being transferred in a solid from a colder region to a hotter region
    C) occur both in solids and fluids
    D) do not require the presence of a material medium
    E) are always steady

13. **What is meant by** *"the entropy of the universe always increases"***?**
    A) the sentence describes an experimental result
    B) it rules the behavior of isolated systems
    C) it states total energy conservation
    D) it states that thermal energy is conserved
    E) it rules the behavior of reversible transformations

14. **Thermal radiation is:**
    A) a mode of heat transfer which does not require the presence of a material medium
    B) a mode of heat transfer which is independent of the temperature of the source
    C) emitted by matter above and below zero degrees Kelvin
    D) a mode of heat transfer whose directional distribution is uniform
    E) transmitted also through a fully opaque medium

15. **Which is the correct definition of aerodynamic drag?**
    A) The sum of all resisting forces in the body longitudinal direction
    B) The sum of forces due to aerodynamic friction
    C) The component in the direction of the free stream of all aerodynamic forces applied to the body
    D) The sum of all pressure forces applied to the vehicle body
    E) The resultant vector of all aerodynamic forces applied to the vehicle body

16. **In the International System of Quantities, the basic units for electric current, thermodynamic temperature, amount of substance are:**
    A) V; K; mol
    B) A; K; mol
    C) A; °C; mol
    D) A; K; kmol
    E) kg/s; K; mol

17. **A time-dependent pressure can be directly measured by means of a:**
    A) barometer
    B) dynamometer
    C) piezo-resistive transducer
    D) thermocouple
    E) thermoresistance

18. **A pressure of 10 mm_H2O corresponds to:**
    A) About 10 Pa
    B) About 100 Pa
    C) About 1000 Pa
    D) About 10 kPa
    E) About 10 mbar

19. **What is the physical quantity measured by a strain gauge coupled to a Wheatstone bridge?**
    A) A force
    B) A variation of temperature
    C) A variation of pressure
    D) A variation of electrical resistance proportional to a variation of length
    E) A variation of voltage proportional to a variation of temperature

20. **Using a Pitot tube:**
    A) one can measure the local static pressure of a gas
    B) one can measure the local total pressure of a gas
    C) one can measure the local static temperature of a gas
    D) one can measure the local total temperature of a gas
    E) one can measure the local velocity of a gas

21. **In the spur gear shown in the figure, d is the pitch diameter. With reference to the symbols of the figure, which is the correct formulation for module (or modulus)?**
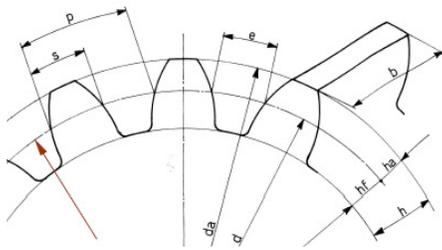
    A) $\dfrac{p}{\pi}$
    B) $2\pi p$
    C) $s + e$
    D) h
    E) πd

22. **In the gearbox shown in the next figure, gear 1 is the input gear and gear 4 is the output gear. z_1, z_2, z_3, z_4 are the number of teeth of gears 1, 2, 3, 4, respectively.**
Which is the correct formulation for the ratio between the angular velocity of input gear 1 and output gear 4?
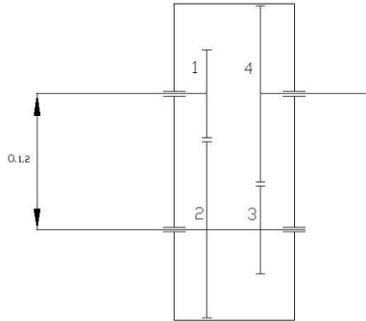
A) $\dfrac{z_3}{z_1}$

B) $\dfrac{z_4}{z_1}$

C) $\dfrac{z_1 z_3}{z_2 z_4}$

D) $\dfrac{z_2 z_4}{z_1 z_3}$

E) $\dfrac{z_1}{z_4}$

23. **In a single-degree-of-freedom linear oscillator without damping, with spring stiffness k measured in N/m and mass m measured in kg, which is the relation giving the natural frequency of the free vibration in Hz?**

A) $\sqrt{\dfrac{k}{m}}$

B) $2\pi\sqrt{\dfrac{k}{m}}$

C) $\dfrac{1}{2\pi}\sqrt{\dfrac{k}{m}}$

D) $\sqrt{\dfrac{m}{k}}$

E) $\dfrac{m}{k}$

24. **Which is the order of magnitude of the friction coefficient in hydrodynamic bearings?**
   A) 1
   B) 10^{-1}
   C) 10^{-2}
   D) 10^{-3}
   E) 10^{-4}

25. **Figure (a) represents a simply supported beam loaded by three transverse concentrated forces of unknown intensity. Figures (b), (c), (d) represent three possible profiles of the bending moment acting on the beam. Which of the displayed profiles is correct?**
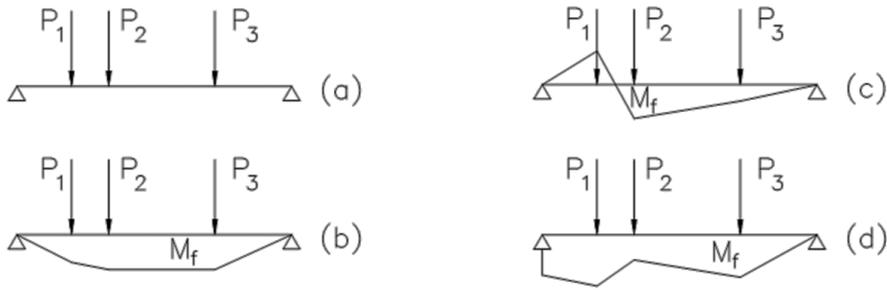
A) Profile (b)
B) Profile (c)
C) Profile (d)
D) All of them
E) None of them

26. **With reference to the points A, B and C in the Figure:**
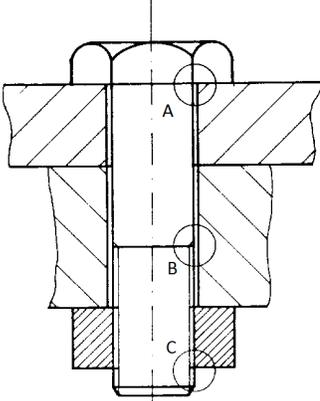
A) points A and C represent critical points for the bolt while point B is not critical
B) points A and B represent critical points for the bolt while point C is not critical
C) points B and C represent critical points for the bolt while point A is not critical
D) points A, B anc C represent critical points for the bolt
E) points A, B anc C are not critical points for the bolt

27. **For a steel component, is it possible to register a maximum equivalent stress equal to −137 MPa?**
A) Yes, since an equivalent stress is always negative
B) Yes, since an equivalent stress can be positive, negative or null
C) No, since an equivalent stress is always positive
D) No, since an equivalent stress is always greater than the Young modulus of the material
E) Yes, since an equivalent stress is always smaller than the Young modulus of the material

28. **Consider the fracture in the Figure. It is a typical:**
A) fatigue fracture of a ductile material
B) fatigue fracture of a brittle material
C) static collapse of a ductile material
D) static collapse of a brittle material
E) fatigue fracture independent of whether the material is ductile or brittle

29. **Consider the conrod of a high speed internal combustion engine. With reference to the conrod shank, it is loaded:**
    A) only by torque loadings
    B) only by bending loadings
    C) only by traction forces
    D) only by compression forces
    E) by both traction and compression forces

30. **Which is the exact meaning of the symbol here represented?**
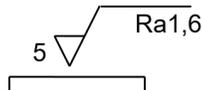
    A) roughness: 5 µm, machining allowance: 1,6 mm
    B) roughness: 1,6 µm, machining allowance: 5 µm
    C) roughness: 1,6 µm, machining allowance: 5 mm
    D) roughness: 1,6 µm, flatness: 5 µm
    E) roughness: 1,6 mm, machining allowance: 5 mm

31. **Which of the following elements must not be hatched in sections?**
    A) Ribs
    B) Hubs
    C) Connecting plates
    D) Trading parts
    E) Ribs, only if the cutting plane crosses them parallel to their larger dimension

32. **By denoting the *"D"* and *"d"* diameters of two sections of a cone (with *D > d*), *"L"* the distance between the sections themselves, the relation expressing the value of the *"conicity"* C In function of *D*, *d*, *L* is:**
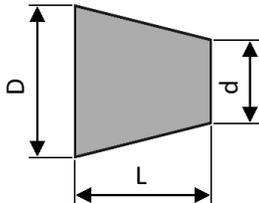
    A) $L/(D-d)$
    B) $(D-d)/L$
    C) $L/D-d$
    D) $L \cdot D-d$
    E) $D-(d/L)$

33. **What kind of loads does the ball bearing represented in the figure bear?**

    A) Only radial
    B) Only axial
    C) Both radial and axial
    D) It cannot bear loads but only decreases the rolling friction
    E) None of them

34. Which is the correct meaning of the geometric tolerance represented in the following figure?

$$\boxed{\perp \mid 0,08 \mid A}$$
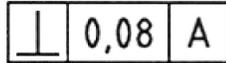
- A) The toleranced feature must be between two parallel planes, which are distant 0.08mm between them and are parallel to reference datum A
- B) The toleranced feature must be between two parallel planes, which are distant 0.08mm between them, and are perpendicular to reference datum A
- C) The toleranced feature must be between two orthogonal planes, which are 0.08mm distant from reference datum A
- D) The toleranced feature can be inclined by 0.08°, compared to the reference datum A
- E) The toleranced feature must be perpendicular to reference datum A, for a maximum of 0.08°

35. Which component is represented in the following figure?
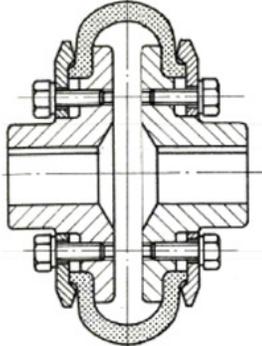
- A) rigid disc coupling
- B) welded joint
- C) simplecardanjoint
- D) elastic coupling
- E) Lamellar joint

36. In metal casting, risers should have:
- A) a large-enough volume to avoid the formation of the shrinkage pipe
- B) a large-enough radius in order to ensure easy metal pouring
- C) a high enough volume/surface ratio to be the last solidifying region
- D) a large-enough volume to counterbalance the metallostatic force
- E) a large-enough volume to avoid the formation of the shrinkage pipe and to counterbalance the metallostatic force, as well as a high enough volume/surface ratio to be the last solidifying region

37. Sand casting is characterized by:
- A) permanent mould, expendable pattern and cores
- B) permanent pattern, expendable mould and cores
- C) expendable mould, permanent pattern and cores
- D) expendable mould, pattern and cores
- E) permanent mould, pattern and cores

38. Extrusion pressure as a function of the ram travel:
A) is generally lower in direct than in indirect extrusion, because indirect layout causes higher friction
B) is generally higher in direct than in indirect extrusion, and in the latter it is constant during most of the ram travel
C) decreases continuously as a function of the ram travel in direct extrusion, because of the shift from sticking to sliding friction
D) is independent on the cross-sectional area of the billet
E) is generally higher in direct than in indirect extrusion, and in the latter it is constant during most of the ram travel. In direct extrusion, it decreases continuously as a function of the ram travel, because of the shift from sticking to sliding friction

39. In machining operations a positive rake angle:
A) reduces power requirements
B) avoids contact between the tool flank and the machined surface
C) is advantageous for ceramic tools
D) causes the formation of fragmented chip
E) increases the cutting force

40. In a turning operation, the roughness of the machined surface depends on:
A) the ratio between feed and the tool nose radius
B) the ratio between the square of feed and the tool nose radius
C) the ratio between the square of the depth-of-cut and the tool nose radius
D) the product of the square of feed and the tool nose radius
E) the ratio between the tool nose radius and the square of feed

41. In a drilling operation, the torque on the drill bit depends on:
A) the depth of cut
B) the square of feed
C) the square of the hole diameter
D) the revolutions per minute of the drill bit
E) the square of feed, the square of the hole diameter and the revolutions per minute of the drill bit

42. What is an industrial Supply Chain?
A) An iron chain to move goods in a ship
B) A management tool for the product design
C) A product forecasting method
D) A system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer
E) The process of evaluating and approving potential suppliers by quantitative assessment

43. What is the main use of an Automatic Storage and Retrieval system (AS/RS)?
A) To assembly product, in particular "high volume" product
B) To stock product when there are a lot picking action to do
C) To move product from storage systems to assembly lines
D) The stock product when there aren't picking action to do
E) To move product from assembly lines to storage systems

44. **The setup time is:**
    A) the average time used for the production of a batch of products
    B) the time to change a supplier
    C) the average time between the end of a production of a batch and the start of production of the next batch of product
    D) the time to develop a new product
    E) the opening time of a production system

45. **The constant instalment amortization is:**
    A) a softening system for sport vehicles
    B) a way to spread an investment cost over more years
    C) a method to increase your revenue
    D) a method to increase the company taxes
    E) a constant demand forecasting method

46. **What is a method to evaluate the return of an industrial investment?**
    A) The opportunity cost of capital, OCC
    B) The net present value, NPV
    C) The supply chain management, SCM
    D) The cost diagram
    E) The just in time, JIT

47. **The Kirchoff law for currents, written for a stationary electric circuit, says that:**
    A) in a single node, the sum of the currents flowing into the node equals the sum of currents flowing out of the node
    B) in a single node, the sum of the currents flowing out of the node is greater than the sum of currents flowing into the node
    C) in a single node, the sum of the currents flowing into the node equals the currents flowing into the two adjacent nodes
    D) in a single node, the sum of the currents flowing into the node is zero
    E) in a single node, the sum of the currents flowing out of the node is zero

48. **The Gauss law for magnetism says that the flux of a magnetic field across a closed surface:**
    A) is always null
    B) is null only if the magnetic field is stationary
    C) is larger than zero if inside the closed surface there are electric positive charges
    D) is lower than zero if inside the closed surface there are electric negative charges
    E) is null only if inside the closed surface there are no currents

49. **In a straight, stationary wire, of length L, carrying a current I, placed in a magnetic field B, the force F generated on the conductor is:**
    A) proportional to the current I and to the line-integral along L of the vector product between B and the direction of the current.
    B) proportional to the amplitude of the current I and to the field B
    C) proportional to the current I only
    D) proportional to the relative speed of the conductor with respect to the magnetic field B
    E) proportional to the amplitude of the current I, to the amplitude of the field B and to the frequency of variation of B

50. **A sinusoidal signal with frequency f_0 and phase Φ_0 is fed into a linear filter with frequency response function (f) . The output signal:**
   A) is a triangular wave with frequency f_0
   B) is a sinusoidal wave with frequency $f_0 + arg(H(f_0))$
   C) is a sinusoidal wave with an amplitude that is $|H(f_0)|$ times the amplitude of the input signal
   D) is a sinusoidal wave with phase Φ_0 if and only if $arg\{H(f_0)\} = 0$
   E) is a triangular wave with an amplitude that is half of the amplitude of the input signal

51. **Let $x \in [-1,1]$ be an analog value that goes through a uniform quantization and is represented by a digital word expressing integers $k = -128,\dots,127$. We know that:**
   A) at least 16 bits are used to represent x
   B) the minimum possible quantization interval is 2^{-7}
   C) the maximum quantization error is not larger than 2^{-8}
   D) the quantization error is uniformly distributed in the interval $[-2^{-8}, 2^{-8}]$
   E) the value $x = +1$ cannot be represented

52. **An acquisition system outputs 64 samples/s, each of them represented by a 8bit word. Samples are processed by a microcontroller and compressed without any loss of information to be transmitted through a serial channel capable of 128 bit/s. Transmission cannot accumulate delays. The compression algorithm running in the microcontroller:**
   A) must compress the data of a factor at least 4
   B) can compress the data of a factor lower than 4
   C) must compress each 8 bit word into a 2 bit word
   D) can expand each 8 bit word into a 128 bit word
   E) must re-encode every group of 4×8 bit words into a single 8 bit word

53. **The manufacturing industry is defined as:**
   A) the production of merchandise using labour and machines in which raw materials are transformed into finished goods
   B) the cultivation and breeding of animals, plants for human feeding
   C) an industry, such as the chemical or petrochemical industry, that is concerned with the processing of bulk resources into other products
   D) the food and beverage industry
   E) the automotive sector only

54. **The product cycle time is:**
   A) The lead time from the beginning of the production process (raw material) to its end (finished good)
   B) The supply chain time
   C) The time availability for the manufacturing process of one product in a workstation
   D) The shift duration
   E) The number of working hours per day in a production plant

55. **In order to increase the Unit Contribution Margin a company could:**
   A) increase production capacity in order to increase production volume
   B) decrease unit selling price
   C) decrease unit variable cost
   D) increase the fixed indirect costs
   E) all the other choices are true statements

56. **Which of the following items is not subject to amortization:**
    A) land
    B) patents
    C) software
    D) office furniture
    E) all the other choices are true statements

57. **Billy Ltd at 31/12/2009 has a net income of Euro 30,000, an ROE of 5% and, considering the financial year 2009, pays taxes for 50,000 Euro and interests for 20,000 Euro on financial debts of 400,000 Euro. The ROI for Billy Ltd equals:**
    A) The data provided are not sufficient to compute the ROI
    B) 3%
    C) 10%
    D) 5%
    E) 7%

58. **The resistance of a wire with a constant radius round section**
    A) is proportional to the wire length and radius
    B) causes the wire to transform electric energy into heat at a rate proportional to the current flowing through it
    C) causes a voltage drop across the wire proportional to the current flowing through it
    D) causes the current leaving the wire at one end to be smaller than the current entering it at the other end
    E) allows a magnetic field to appear around the wire as some current flows through it

59. **According to Fourier analysis, physical signals can be decomposed**
    A) into the superposition of sinusoidal components whose frequencies span a continuous range
    B) into the superposition of two sinusoidal components in quadrature one with the other
    C) into the superposition of vanishing exponential signals
    D) into the sum of a constant component and a time varying component
    E) into a finite number of sinusoidal components whose frequencies are necessarily commensurable

60. **The exclusive OR among two binary signals A and B**
    A) evaluates to one only if A and B have the same value
    B) evaluates to zero only if A and B have the same value
    C) evaluates to one if either A AND B or NOT A AND NOT B evaluates to one
    D) evaluates to A if B is one
    E) evaluates to B if A is one

******** END OF MULTIPLE CHOICE QUESTIONS ********

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	A	B	C	D	E			A	B	C	D	E			A	B	C	D	E			A	B	C	D	E
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○	2	☐	☐	☐	☐	☐	○	17	☐	☐	☐	☐	☐	○	32	☐	☐	☐	☐	☐	○	47	☐	☐	☐	☐	☐
○	3	☐	☐	☐	☐	☐	○	18	☐	☐	☐	☐	☐	○	33	☐	☐	☐	☐	☐	○	48	☐	☐	☐	☐	☐
○	4	☐	☐	☐	☐	☐	○	19	☐	☐	☐	☐	☐	○	34	☐	☐	☐	☐	☐	○	49	☐	☐	☐	☐	☐
○	5	☐	☐	☐	☐	☐	○	20	☐	☐	☐	☐	☐	○	35	☐	☐	☐	☐	☐	○	50	☐	☐	☐	☐	☐
○	6	☐	☐	☐	☐	☐	○	21	☐	☐	☐	☐	☐	○	36	☐	☐	☐	☐	☐	○	51	☐	☐	☐	☐	☐
○	7	☐	☐	☐	☐	☐	○	22	☐	☐	☐	☐	☐	○	37	☐	☐	☐	☐	☐	○	52	☐	☐	☐	☐	☐
○	8	☐	☐	☐	☐	☐	○	23	☐	☐	☐	☐	☐	○	38	☐	☐	☐	☐	☐	○	53	☐	☐	☐	☐	☐
○	9	☐	☐	☐	☐	☐	○	24	☐	☐	☐	☐	☐	○	39	☐	☐	☐	☐	☐	○	54	☐	☐	☐	☐	☐
○	10	☐	☐	☐	☐	☐	○	25	☐	☐	☐	☐	☐	○	40	☐	☐	☐	☐	☐	○	55	☐	☐	☐	☐	☐
○	11	☐	☐	☐	☐	☐	○	26	☐	☐	☐	☐	☐	○	41	☐	☐	☐	☐	☐	○	56	☐	☐	☐	☐	☐
○	12	☐	☐	☐	☐	☐	○	27	☐	☐	☐	☐	☐	○	42	☐	☐	☐	☐	☐	○	57	☐	☐	☐	☐	☐
○	13	☐	☐	☐	☐	☐	○	28	☐	☐	☐	☐	☐	○	43	☐	☐	☐	☐	☐	○	58	☐	☐	☐	☐	☐
○	14	☐	☐	☐	☐	☐	○	29	☐	☐	☐	☐	☐	○	44	☐	☐	☐	☐	☐	○	59	☐	☐	☐	☐	☐
○	15	☐	☐	☐	☐	☐	○	30	☐	☐	☐	☐	☐	○	45	☐	☐	☐	☐	☐	○	60	☐	☐	☐	☐	☐
		A	B	C	D	E			A	B	C	D	E			A	B	C	D	E			A	B	C	D	E

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Open question 1

Today's product designer is often asked to develop innovative products, meeting high quality standards. Please describe the fundamental role of the integration of advanced design methodologies and Computer Aided Engineering (CAE) techniques in helping the acquisition of design knowledge and creative ideas in industry.

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Open question 2

Describe the geometrical differences between spur and helical gears, as well as the operational advantages and disadvantages of helical gears with respect to spur gears.

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