**Lecture#10 Type of controllers**

**\*** a number of different controllers are used in industry like pharmaceuial and chemical industry and in other field. In quit general these controller can be divided into two groups:

1) conventional controllers 2) unconventional controllers

\*في النوع الأول يجب ان يكون النموذج الرياضي لprocess او plant لغرض تصمبم ال controller

\*في النوع الثاني يسنخدم طرق التصميم ال controllerبحيث ان النموذج الرياضي لprocess او plant يكون غيرمطلوب

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**\* Classifications of Industrial Controllers:** Industrial controllers may be classified according to their control actions as:

**1.** Two-position or on-off controllers

**2.** Proportional controllers (P-controller)

**3.** Integral controllers (I-controller)

4. Proportional-plus-integral controllers (PI-controller)

**5.** Proportional-plus-derivative controllers (PD-controller)

***6.*** Proportional-plus-integral-plus-derivative controllers (PID-controller)

\*in general any controller system must meet some time response specification like:

1-steady state error. 2-damping factor and MP  3-settling time

\*if any controller meet these specifications a controller can be used.

\* u(s) is called (controller output or control action or control signal or actuator signal)

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**1) Two-Position or On-Off Control Action.** In a two-position control system, the actuating element has only two fixed positions, which are, in many cases, simply on and off.Two-position or on-off control is relatively simple and inexpensive and, for this reason, is very widely used in both industrial and domestic control systems.

Let the output signal from the controller be ***u*(*t*)**and the actuating error signal be ***e*(*t*)*.***

In two-position control, the signal ***u(t)*** remains at either a maximum or minimum value, depending on whether the actuating error signal is positive or negative, so that

***u(t)*** = *Kl* for ***e(t)*** > *0*

= *K2*  for ***e(t*)**< *0*

where *K1* and *K2* are constants. *K1*  is maximum gain and *K2* is theminimum gain, the minimum value *K2* is usually either zero or *–Kl.*

**Proportional Control Action.** For a controller with proportional control action, the relationship between the output of the controller ***u(t)*** and the actuating error signal *e(t)* is or, in Laplace-transformed quantities, where ***Kp*** is termed the proportional gain.

Whatever the actual mechanism may be and whatever the form of the operating power, the proportional controller is essentially an amplifier with an adjustable gain.

**Integral Control Action.** In a controller with integral control action, the value of the controller output *u(t)* is changed at a rate proportional to the actuating error signal *e(t).* That is,

where